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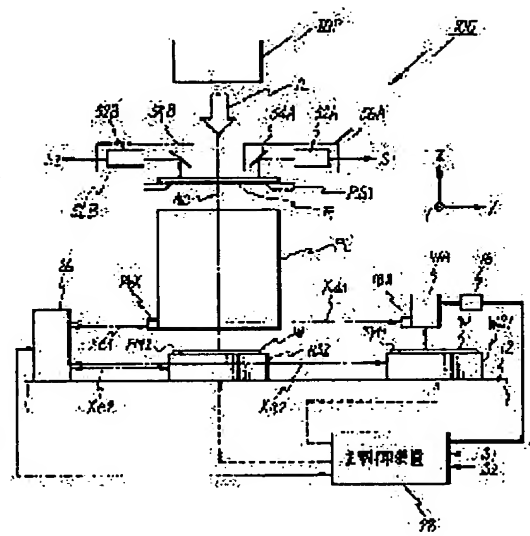
(54) LIGHT-EXPOSURE DEVICE AND LIGHT-EXPOSURE METHOD

(57)Abstract:
PROBLEM TO BE SOLVED: To provide a light-exposure method capable of enhancing the throughput and deciding the size of a substrate stage irrespective of a base line amount.
SOLUTION: For example, while a pattern image of a mask R is exposed to lights via a projection optical system PL on a substrate W held by a stage WS2, a location relations between a positioning mark on the substrate W held by a stage WS1 and a reference point on the stage WS1 is measured. After the substrate W held by the stage WS2 is completed being exposed to lights, under a state that a reference point on the stage WS1 is positioned in a projection region of the projection optical system PL, location deviations of the reference point on the stage WS1 with respect to a specific reference point in the projection region and a coordinate location of the stage WS1 at the time of detecting the location deviations are detected. Thereafter, movements of the stage WS1 are controlled based on the detection results, and the substrate W held by the stage WS1 is positioned to the pattern image of the mask R.



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CLAIMS

[Claim(s)]
[Claim 1] It is the exposure approach which exposes the image of the pattern formed in the mask on an induction substrate through projection optics. Hold an induction substrate and two independently movable substrate stages are respectively prepared for the inside of the same flat surface. The pattern image of said mask is exposed through said projection optics on the induction substrate held on one substrate stage of said two substrate stages. During exposure of the induction substrate held on one [said] substrate stage, the physical relationship of the alignment mark on the induction substrate held on the substrate stage of another side of said two substrate stages and the reference point on the stage of said another side is measured. After exposure termination of the induction substrate held on one [said] substrate stage, the reference point on the substrate stage of said another side in the condition of having positioned in the projection field of said projection optics The coordinate location of a location gap of the origin/datum on the substrate stage of said another side to the predetermined origin/datum in the projection field and the substrate stage of said another side is detected. The exposure approach characterized by performing alignment of the induction substrate which controlled migration of the substrate stage of said another side based on said detected physical relationship, said detected location gap, and said detected coordinate location, and was held on the stage of said another side, and the pattern image of said mask.
[Claim 2] It is the aligner which exposes a pattern on an induction substrate through projection optics. Said projection optics is established independently. an induction substrate -- holding -- the inside of a two-dimensional flat surface -- the movable 1st substrate stage and; induction substrate -- holding -- the inside of the same flat surface as said 1st substrate stage -- said 1st substrate stage -- the independently movable 2nd substrate stage and; -- Interferometer systems for measuring the two-dimensional location of the alignment system for detecting the mark on the induction substrate held on said substrate stage or on this stage, the 1st substrate stage of; above, and the 2nd substrate stage, respectively; each of said two substrate stages The 1st predetermined location in the stage successive range at the time of the exposure to which exposure is performed through said projection optics to the induction substrate held on this stage, By said alignment system On a stage Or the migration means to which it is made to move between the 2nd predetermined location in the stage successive range at the time of the alignment to which mark detection on the induction substrate held on this stage is carried out; while the induction substrate held on one stage of said 1st substrate stage and the 2nd substrate stages is exposed So that mark detection actuation by said alignment system may be performed on the stage of another side of said 1st substrate stage and the 2nd substrate stages The aligner which has the control means which controls said migration means and replaces the location of one [said] substrate stage and the substrate stage of another side after controlling actuation of said two stages, carrying out the monitor of the measurement value of said interferometer systems.
[Claim 3] It is the aligner according to claim 1 characterized by to equip said interferometer systems with the 1st length measurement shaft and the 2nd length measurement shaft which cross at right angles to mutual focusing on projection of said projection optics, and the 3rd length measurement shaft and the 4th length measurement shaft which cross at right angles to mutual focusing on detection of said alignment system, and to reset the length-measurement shaft of said interferometer systems in case said control means replaces the location of the stage of said one side and another side.
[Claim 4] It is the aligner which exposes a pattern on an induction substrate through projection optics. Said projection optics is established independently. an induction substrate -- holding -- the inside of a two-dimensional flat surface -- the movable 1st substrate stage and; induction substrate -- holding -- the inside of the same flat surface as said 1st substrate stage -- said 1st substrate stage -- the independently movable 2nd substrate stage and; -- Interferometer systems for measuring the two-dimensional location of the alignment

system for detecting the mark on the induction substrate held on said substrate stage or on this stage, the 1st substrate stage of; above, and the 2nd substrate stage, respectively; each of said two substrate stages The 1st predetermined location in the stage successive range at the time of the exposure to which exposure is performed through said projection optics to the induction substrate held on the stage, The 2nd predetermined location in the stage successive range at the time of the alignment to which mark detection on the induction substrate held by said alignment system on a stage or on this stage is carried out, The migration means to which delivery of an induction substrate is carried out between a substrate stage and an external substrate conveyance device, and it is made to move among 3 points of the 3rd location of ****; The location of one stage of said 1st substrate stage and the 2nd substrate stages is managed by said interferometer systems. While a pattern is exposed through said projection optics by the induction substrate held on one [this] stage Said 1st substrate stage And the alignment actuation which measures the physical relationship of exchange of an induction substrate and the alignment mark on said induction substrate, and the reference point on the stage of said another side based on the detection result of said alignment system and the measurement value of said interferometer systems on the stage of another side of the 2nd substrate stages While controlling said two substrate stages and said migration means to be carried out one by one The aligner which has the control means which controls said two stages and said migration means so that the actuation performed on said two stages may interchange, after both actuation of said two stages is completed.
[Claim 5] The aligner according to claim 4 with which the image of the pattern which has further the mask with which the pattern was formed and was formed in said mask is characterized by carrying out projection exposure at the induction substrate on said 1st substrate stage and the 2nd substrate stage through projection optics.
[Claim 6] The 1st length measurement shaft and the 2nd length measurement shaft with which said interferometer systems cross at right angles to mutual focusing on projection of said projection optics, It has the 3rd length measurement shaft and the 4th length measurement shaft which cross at right angles to mutual focusing on detection of said alignment system. Said control means The aligner according to claim 5 characterized by resetting the 1st and 2nd length measurement shaft of said interferometer systems in the case of migration in said 1st location, and resetting the 3rd and 4th length measurement shaft of said interferometer systems about each of said two stages in the case of migration in said 2nd location.
[Claim 7] The aligner according to claim 6 characterized by having further a mark location detection means to detect the relative-position relation between the projection core of the pattern image of said mask, and the reference point on said stage through said mask and said projection optics.
[Claim 8] It has the substrate attachment component which said each substrate stage is carried free [attachment and detachment] on a stage body and this body, and holds a substrate. The reflector for interferometers is established in the side face of this substrate attachment component, and a reference mark is formed in the top face of said substrate attachment component as said reference point. An aligner given in claim 2 to which said migration means is characterized by moving said substrate attachment component between said every place points instead of said substrate stage thru/or any 1 term of 7.
[Claim 9] Said migration means is an aligner given in claim 2 characterized by being constituted by the robot arm thru/or any 1 term of 8.
[Claim 10] An aligner given in claim 2 characterized by attaching in said projection optics and said alignment system the fixed mirror which serves as criteria of length measurement by the interferometer, respectively thru/or any 1 term of 9.
[Claim 11] It is an aligner given in claim 2 characterized by holding the induction substrate other than said 1st substrate stage and the 2nd substrate stage, and these stages having further at least one another, independently movable substrate stage for the inside of said two same flat surfaces as a substrate stage thru/or any 1 term of 10.

[Translation done.]

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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] This invention relates to the exposure approach and an aligner, and relates to aligners, such as drawing equipment which carries out direct writing of the pattern on an induction substrate by the charged-particle line of a laser beam, and an electron ray and others etc., for manufactures, such as the exposure approach which exposes the mask pattern used in more detail in case a semiconductor device, a liquid crystal display component, etc. are manufactured at a lithography process on an induction substrate through projection optics and an aligner or a semiconductor device, and a mask for semiconductor device manufacture. This invention has the description at the point of having two or more substrate stages holding an induction substrate.
[0002]
[Description of the Prior Art] Although various aligners are conventionally used when manufacturing a semiconductor device or a liquid crystal display component at a photolithography process In current, a photo mask or the pattern image of a reticle (it is hereafter named a "reticle" generically) Generally the projection aligner imprinted on substrates (an "induction substrate" or a "wafer" is called suitably hereafter), such as a wafer with which sensitization material, such as a photoresist, was applied to the front face through projection optics, or a glass plate, is used. The so-called contraction projection aligner (the so-called stepper) of the step-and-repeat method which lays an induction substrate on a freely movable substrate stage two-dimensional, is made to carry out stepping (stepping) of the induction substrate by this substrate stage as this projection aligner in recent years, and repeats the actuation which carries out sequential exposure of the pattern image of a reticle to each shot field on an induction substrate is in use.
[0003] Comparatively many projection aligners (for example, scanning aligner which was indicated by JP,7-176468,A) of step - which added amelioration to quiescence mold aligners, such as this stepper, and - scanning method have also recently come to be used. It has the equalization effectiveness by carrying out the relative scan of a reticle and the wafer to ** projection optics which can expect a high throughput by reduction of the shots per hour by large field exposure, and has a merit with the expectable improvement in distortion or the depth of focus while manufacture of projection optics is easy for it, since the projection aligner of this step - and - scanning method can expose the large field by smaller optical system compared with ** stepper.
[0004] In this kind of projection aligner, it is necessary to perform alignment (alignment) of a reticle and a wafer with high precision in advance of exposure. In order to perform this alignment, on the wafer, the mark for location detection (alignment mark) formed at the former photolithography process (exposure imprint) is prepared, and the exact location of a wafer (or circuit pattern on a wafer) can be detected by detecting the location of this alignment mark.
[0005] Although there is a thing of the on-axis method which divides roughly and performs mark detection through a projection lens as an alignment microscope which detects an alignment mark, and the off axis method which performs mark detection without a projection lens, in the projection aligner using the excimer laser which will become the future mainstream, the alignment microscope of an off axis method is the optimal. Since amendment of chromatic aberration is made to exposure light, this a projection lens As opposed to the error by chromatic aberration becoming very big, even if in the case of an on-axis it cannot condense alignment light or is able to condense the alignment microscope of an off axis method It is because a free optical design's being possible and various alignment systems can be used, without taking such chromatic aberration into consideration, since it is prepared apart from the projection lens. For example, a phase-contrast microscope, a differential interference microscope, etc. can be used.

[0006] By the way, the flow of the processing in this kind of projection aligner has become like size Yoji.
[0007] ** The wafer load process which loads a wafer on a wafer table using a wafer loader is performed first, and the so-called search alignment is performed by being based on a wafer appearance subsequently etc.
[0008] ** Next, the fine alignment process which asks for the location of each shot field on a wafer correctly is performed. Generally as for this fine alignment process, an EGA (en hunger strike global alignment) method is used. This method Choose two or more sample shots in a wafer, and sequential measurement of the location of the alignment mark (wafer mark) attached to the sample shot concerned is carried out. Based on this measurement result and the design value of a shot array, the statistics operation by the so-called least square method etc. is performed. It can ask for all the shot array data on a wafer, and can ask for the coordinate location of each shot field comparatively with high precision by the high throughput (reference, such as JP,61-44429,A).
[0009] ** Next, the exposure process which imprints the pattern image of a reticle on a wafer through projection optics is performed, carrying out sequential positioning of each shot field on a wafer in an exposure location based on the coordinate location of each shot field for which it asked with the EGA method mentioned above, and the amount of base lines measured beforehand.
[0010] ** Next, the wafer unload process to which the unload of the wafer on the wafer table by which exposure processing was carried out is carried out using a wafer unloader is performed. This wafer unload process is performed to the wafer load process and coincidence of the above-mentioned **. That is, a wafer exchange process is constituted by ** and **.
[0011] thus -- the conventional projection aligner -- wafer exchange (search alignment is included) -> fine alignment -> exposure -> wafer exchange -- like ...., three actuation is greatly performed repeatedly using one wafer stage.
[0012]
[Problem(s) to be Solved by the Invention] It is requested inevitably that the throughput, i.e., a throughput, whether it can carry out exposure processing of the wafer of the number of sheets of which in fixed time amount since the projection aligner mentioned above is used mainly as mass-production machines, such as a semiconductor device, should be raised.
[0013] Although it is necessary about this to shorten the time amount which each actuation takes from three actuation mentioned above being performed sequentially with the present projection aligner for the improvement in a throughput, since 1 actuation is only performed to one wafer, the wafer exchange (search alignment is included) of the effectiveness of an improvement is comparatively small. Moreover, in case the EGA method mentioned above is used for the time amount which fine alignment takes, it can be shortened by lessening the number of samplings of a shot or shortening the measurement time amount of a shot simple substance, but since alignment precision is made to deteriorate on the contrary, these things cannot shorten the time amount which fine alignment takes easily.
[0014] Therefore, although it will be said that it is the most effective in order for it to be improvement in a throughput to shorten conclusively the time amount which exposure takes Although the pure wafer exposure time and the stage stepping time between shots are included in this exposure actuation in the case of the stepper and it becomes indispensable that the quantity of light of the light source is large at compaction of the wafer exposure time In this kind of projection aligner, as important conditions besides the above-mentioned throughput side There are resolution, ** depth of focus (DOF:Depth of Forcus), ** line breadth control precision, etc. ** Resolution R When exposure wavelength is set to lambda and numerical aperture of a projection lens is made into N.A. (Numerical Aperture), it is proportional to lambda/N.A., and the depth of focus DOF is lambda/2 (N.A.). It is proportional. For this reason, it is the bright line (g lines) of the extra-high pressure mercury lamp which it is required for wavelength to be also short as the light source, and was used conventionally. It is said that the excimer laser previously described as what satisfies the requirements for both that power is large compared with i line etc., and it is short wavelength becomes the future mainstream, wavelength is shorter than this, the quantity of light is large, and the light source suitable as the light source of an aligner is not considered at a present stage. Therefore, when using excimer laser as the light source, the improvement in the above throughput can seldom be expected, but there is a limitation also in improvement in the throughput by the device of the light source.
[0015] On the other hand, the improvement in full speed and the highest acceleration having un-arranged [of being easy to cause degradation of the positioning accuracy of a stage], although the full speed of the stage holding a wafer and the highest acceleration needed to be raised for compaction of the stage stepping time between shots. In addition, although compaction of the exposure time of a wafer is possible for the case

of a scanning projection aligner like step - and - scanning method by gathering the relative scan speed of a reticle and a wafer, since the improvement in a relative scan speed tends to cause degradation of synchronous precision, a scan speed cannot be gathered easily. Therefore, it is necessary to raise the controllability of a stage.

[0016] However, it is not easy to raise the controllability of a stage with the equipment using an off-axis alignment microscope like the projection aligner using the excimer laser which will become the mainstream especially from now on. At namely, the time of exposure of the mask pattern which minds projection optics in this kind of projection aligner In order to manage the location of a wafer stage correctly without an Abbe error in both times of alignment and to realize highly precise superposition It is necessary to set up so that the length measurement shaft of a laser interferometer may pass along the projection core of projection optics, and the detection core of an alignment microscope, respectively. And since it is necessary to make it both the length measurement shaft which passes along the projection core of said projection optics by both with the inside of the successive range of the stage at the time of alignment in the successive range of the stage at the time of exposure, and the length measurement shaft passing through the detection core of an alignment microscope not go out, It is because a stage is enlarged inevitably.

[0017] As mentioned above, by the technique of shortening the time amount which each actuation of three actuation mentioned above takes, it is difficult to raise a throughput without any demerit, and looked forward to the appearance of the new technique which raises a throughput by technique different from this.

[0018] This invention was made under this situation, and the purpose of invention according to claim 1 is to offer the exposure approach that the magnitude of a substrate stage can be defined regardless of the amount of base lines while being able to raise a throughput.

[0019] Moreover, claim 2 thru/or the purpose of invention given in 11 are to offer the aligner which can raise a throughput.

[0020]

[Means for Solving the Problem] If three actuation mentioned above, i.e., wafer exchange, (search alignment is included), fine alignment, and two or more actuation of the exposure actuation can be processed in [that it is also partial] concurrency, it will be thought compared with the case where these actuation is performed sequentially that a throughput can be raised. This invention was made paying attention to this viewpoint, and following approaches and configurations are used for it. Namely, invention according to claim 1 is the exposure approach which exposes the image of the pattern formed in the mask (R) on an induction substrate (W) through projection optics (PL). An induction substrate (W) is held. Prepare two independently movable substrate stages (WS1, WS2) for the inside of the same flat surface respectively, and said projection optics (PL) is minded on; induction substrate (W) held on one substrate stage (WS1 or WS2) of said two substrate stages (WS1, WS2). During exposure of the induction substrate (W) which exposed the pattern image of said mask (R) and was held on; aforementioned one substrate stage (WS1 or WS2) After exposure termination of the induction substrate which measured the physical relationship of the alignment mark on the induction substrate (W) held on the substrate stage (WS2 or WS1) of another side of said two substrate stages, and the origin/datum on the stage (WS2 or WS1) of said another side, and was held on; aforementioned one substrate stage In the condition of having positioned in the projection field of said projection optics (PL), the reference point on the substrate stage of said another side The physical relationship by which detected the coordinate location of a location gap of the origin/datum on the substrate stage of said another side to the predetermined origin/datum in the projection field, and the substrate stage of said another side, and the; aforementioned detection was carried out, Based on said detected location gap and said detected coordinate location, migration of the substrate stage of said another side is controlled, and it is characterized by performing alignment of the induction substrate held on the stage of said another side, and the pattern image of said mask.

[0021] While exposure of the pattern image of said mask (R) is performed through said projection optics (PL) on the induction substrate (W) held on one substrate stage (WS1 or WS2) of the two substrate stages (WS1, WS2) according to this ** The physical relationship of the alignment mark on the induction substrate (W) held on the substrate stage (WS2 or WS1) of another side of the two substrate stages and the reference point on the stage (WS2 or WS1) of another side is measured. Thus, since exposure actuation by the side of one substrate stage and alignment actuation by the side of the substrate stage of another side (measurement of the physical relationship of the alignment mark on the induction substrate held on the substrate stage of another side and the reference point on the stage of another side) can be performed in parallel, it is possible to aim at improvement in a throughput compared with the conventional technique in which these actuation was performed sequentially.

[0022] and the condition positioned the reference point on the substrate stage (WS2 or WS1) of said another side in the projection field of projection optics (PL) after exposure termination of the induction substrate held on one above-mentioned substrate stage -- ** -- a location gap and ** of the reference point on the substrate stage of another side to the predetermined reference point in the projection field -- the coordinate location of the substrate stage of another side at the time of the location gap detection is detected. Based on the physical relationship of which ** detection was done, the location gap of which ** detection was done, and the coordinate location of which ** detection was done, migration of the substrate stage (WS2 or WS1) of another side is controlled after that, and alignment of the induction substrate held on the stage of another side and the pattern image of said mask is performed.
[0023] For this reason, the interferometer which manages the location of the substrate stage concerned at the time of physical relationship detection with the predetermined origin/datum on the substrate stage of another side of **, and the alignment mark on an induction substrate (or system of coordinates), ** There is nothing. any [even when the interferometer (or system of coordinates) which manages the location of the stage in the case of location gap detection of ** and detection of the coordinate location of a substrate stage is the same, even if it differs] -- inconvenient -- Alignment of the pattern image of a mask and the induction substrate carried in the substrate stage of said another side can be performed with high precision.
[0024] Therefore, when [for example,] the alignment system of an off axis is used as a mark detection system which detects an alignment mark, The predetermined reference point in the projection field of projection optics (projection core of the pattern image of a mask), and the physical relationship based on [of an alignment system] detection, Namely, since measurement of the amount of base lines becomes unnecessary, and there is no un-arranging even if projection optics and an alignment system are greatly separated as a result The magnitude of a substrate stage can be set up regardless of the amount of base lines, and even if it lightweight[small and]-izes a substrate stage, any pattern which minded mark location measurement and projection optics to the whole surface of an induction substrate can be exposed that there is nothing inconvenient. In this case, it is not influenced by the amount of base lines of fluctuation.
[0025] Invention according to claim 2 is an aligner which exposes a pattern on an induction substrate (W) through projection optics (PL). Hold an induction substrate (W) and the movable 1st substrate stage (WS1) and; induction substrate (W) are held for the inside of a two-dimensional flat surface. The inside of the same flat surface is independently established in the 2nd substrate stage (WS2) where said 1st substrate stage (WS1) is independently movable, and the; aforementioned projection optics (PL) as said 1st substrate stage (WS1). On said substrate stage (WS1, WS2) Or interferometer systems for measuring the two-dimensional location of the alignment system (WA) for detecting the mark on the induction substrate (W) held on this stage, the 1st substrate stage of; above, and the 2nd substrate stage, respectively (26); each of said two substrate stages The 1st predetermined location in the stage successive range at the time of the exposure to which exposure is performed through said projection optics to the induction substrate held on this stage, By said alignment system On a stage or the migration means (20 --) to which it is made to move between the 2nd predetermined location in the stage successive range at the time of the alignment to which mark detection on the induction substrate held on this stage is carried out While the induction substrate held on one stage of 22), the; 1st substrate stage, and the 2nd substrate stages is exposed So that mark detection actuation by said alignment system (WA) may be performed on the stage of another side of said 1st substrate stage and the 2nd substrate stages After controlling actuation of said two stages, carrying out the monitor of the measurement value of said interferometer systems (26), it has the control means (28) which controls said migration means (20 22) and replaces the location of one [said] substrate stage and the substrate stage of another side.
[0026] While the induction substrate held on one stage is exposed by the control means (28) according to this, so that mark detection actuation by the alignment system (WA) may be performed on the stage of another side After actuation of two stages is controlled carrying out the monitor of the measurement value of interferometer systems (26), a migration means (20 22) is controlled and exchange of the location of one substrate stage and the substrate stage of another side is performed. For this reason, by parallel processing of the exposure actuation by the side of one substrate stage, and the alignment actuation by the side of the stage of another side, while improvement in a throughput is possible If it is made to exchange an induction substrate on the substrate stage located after exchange of a location in the 2nd location Actuation of both stages is replaced, and while the induction substrate held on the stage of another side is exposed, it becomes possible to perform mark detection actuation by the alignment system (WA) in parallel on one stage.
[0027] Invention according to claim 3 is set to an aligner according to claim 2. Said interferometer systems (26) The 1st length measurement shaft (Xe) and the 2nd length measurement shaft (Ye) which cross at right

angles to mutual focusing on projection of said projection optics (PL), It has the 3rd length measurement shaft (Xa) and the 4th length measurement shaft (Ya) which cross at right angles to mutual focusing on detection of said alignment system (WA). Said control means (28) In case the location of the stage of said one side and another side is replaced, it is characterized by resetting the length measurement shaft (Xe, Ye, Xa, Ya) of said interferometer systems (26).

[0028] The 1st length measurement shaft (Xe) and the 2nd length measurement shaft (Ye) with which interferometer systems (26) cross at right angles to mutual focusing on projection of projection optics (PL) according to this, From having the 3rd length measurement shaft (Xa) and the 4th length measurement shaft (Ya) which cross at right angles to mutual focusing on detection of an alignment system (WA) The location of a substrate stage (WS1, WS2) is correctly manageable without the error of ABBE at the time of any at the time of exposure of the pattern to the induction substrate top through projection optics, and detection of the location detection mark by the alignment system. Moreover, in case a control means (28) replaces the location of the stage of one side and another side Since the length measurement shaft (Xe, Ye, Xa, Ya) of interferometer systems (26) is reset, even if the length measurement shaft of the interferometer systems which had managed the location of each substrate stage till then on the occasion of exchange of a location once goes out If the location which resets the length measurement shaft (Xe, Ye, Xa, Ya) of interferometer systems (26) is beforehand set to the position, it will become possible after reset to manage the location of the 1st and 2nd substrate stage using the measurement value of the reset length measurement shaft.

[0029] Invention according to claim 4 is an aligner which exposes a pattern on an induction substrate (W) through projection optics (PL). Hold an induction substrate (W) and the movable 1st substrate stage (WS1) and; induction substrate (W) are held for the inside of a two-dimensional flat surface. Said projection optics (PL) is established independently. the inside of the same flat surface as said 1st substrate stage (WS1) -- said 1st substrate stage -- the independently movable 2nd substrate stage (WS2) and; -- Interferometer systems for measuring the two-dimensional location of the alignment system (WA) for detecting the mark on the induction substrate held on said substrate stage or on this stage, the 1st substrate stage of; above, and the 2nd substrate stage, respectively (26); each of said two substrate stages The 1st predetermined location in the stage successive range at the time of the exposure to which exposure is performed through said projection optics (PL) to the induction substrate (W) held on the stage, The 2nd predetermined location in the stage successive range at the time of the alignment to which mark detection on the induction substrate held by said alignment system (WA) on a stage or on this stage is carried out, The location of one stage of the migration means (20 22) and the; 1st substrate stage (WS1) to which delivery of an induction substrate is performed between a substrate stage and an external substrate conveyance device, and it is made to move among 3 points of the 3rd location of ****, and the 2nd substrate stages (WS2) Said interferometer systems While a pattern is exposed through said projection optics (PL) by the induction substrate (W) which was managed by (26) and held on one [this] stage Said 1st substrate stage On the stage of another side of the 2nd substrate stages, and an induction substrate Exchange of (W) And said induction substrate (W) So that alignment actuation which measures the physical relationship of the upper alignment mark and the reference point on the stage of said another side based on the detection result of said alignment system (WA) and the measurement value of said interferometer systems (26) may be performed one by one While controlling said two substrate stages (WS1, WS2) and said migration means (20 22) After both actuation of said two stages is completed, it has the control means (28) which controls said two stages and said migration means so that the actuation performed on said two stages may interchange.

[0030] According to this, the location of one substrate stage is managed by interferometer systems by the control means. While a pattern is exposed through projection optics by the induction substrate held on one [this] substrate stage On the substrate stage of another side, exchange of an induction substrate (W) And the induction substrate after the exchange (W) So that alignment actuation which measures the physical relationship of the upper alignment mark and the reference point on the stage of another side based on the detection result of an alignment system (WA) and the measurement value of interferometer systems (26) may be performed one by one Two substrate stages (WS1, WS2) and a migration means (20 22) are controlled. For this reason, much more improvement in a throughput is possible by parallel processing with exchange of the induction substrate by the side of the exposure actuation by the side of one substrate stage, and the stage of another side, and alignment actuation. In this case, since exchange of an induction substrate is performed in the 3rd different location from the 1st location and the 2nd location, this exchange can be performed in a location different from an alignment system and projection optics, and there is also no un-arranging [that an alignment system and projection optics become the hindrance of exchange of an induction substrate].

[0031] Moreover, in both control means, after actuation of two stages is completed, so that the actuation performed on two stages may interchange From controlling two stages and migration means, after termination of the two above-mentioned stages of operation this -- then, while the induction substrate held on the stage of another side is exposed, it becomes possible to perform mark detection actuation by the alignment system (WA) in parallel on one stage.
[0032] In this case, although direct writing of the pattern may be carried out with an electron beam on an induction substrate, using for example, an electronic lens-barrel as projection optics The mask (R) with which the pattern was formed like invention according to claim 5 is prepared further. The projection exposure of the image of the pattern formed in said mask (R) may be made to be carried out at the induction substrate (W) on said 1st substrate stage (WS1) and the 2nd substrate stage (WS2) through projection optics (PL).
[0033] Invention according to claim 6 is set to an aligner according to claim 5. Said interferometer systems (26) The 1st length measurement shaft (Xe) and the 2nd length measurement shaft (Ye) which cross at right angles to mutual focusing on projection of said projection optics (PL), It has the 3rd length measurement shaft (Xa) and the 4th length measurement shaft (Ya) which cross at right angles to mutual focusing on detection of said alignment system (WA). Said control means (28) About each of said two stages (WS1, WS2), the 1st and 2nd length measurement shaft (Xe and Ye) of said interferometer systems (26) is reset in the case of migration in said 1st location. It is characterized by resetting the 3rd and 4th length measurement shaft (Xa and Ya) of said interferometer systems (26) in the case of migration in said 2nd location.
[0034] The 1st length measurement shaft (Xe) and the 2nd length measurement shaft (Ye) with which interferometer systems (26) cross at right angles to mutual focusing on projection of projection optics (PL) according to this, From having the 3rd length measurement shaft (Xa) and the 4th length measurement shaft (Ya) which cross at right angles to mutual focusing on detection of an alignment system (WA) The location of a substrate stage (WS1, WS2) is correctly manageable without the error of ABBE at the time of any at the time of exposure of the pattern to the induction substrate top through projection optics, and detection of the location detection mark by the alignment system. A control means (28) moreover, about each of two stages (WS1, WS2) The 1st and 2nd length measurement shaft (Xe and Ye) of interferometer systems (26) is reset in the case of migration in the 1st location. From resetting the 3rd and 4th length measurement shaft (Xa and Ya) of interferometer systems (26) in the case of migration in the 2nd location The length measurement shaft needed in each actuation before exposure initiation and alignment measurement initiation also about which substrate stage is resettable. Even if the length measurement shaft of the interferometer systems which had managed the location of each substrate stage till then once goes out, it becomes possible after reset to manage the location of both the stages at the time of alignment using the measurement value of the reset length measurement shaft at the time of exposure.
[0035] In this case, it is desirable like invention according to claim 7 to have further a mark location detection means (52A, 52B) to detect the relative-position relation between the projection core of the pattern image of said mask (R) and the reference point on said stage through said mask (R) and said projection optics (PL). In this case, when a substrate stage (WS1, WS2) is positioned in the location where detection of the predetermined origin/datum on a substrate stage (18) and the physical relationship based on [of a mask pattern image] projection is attained in the projection field of projection optics (PL) The physical relationship of the projection core of the pattern image of a mask (R) and the reference point on a substrate stage is detectable through a mask (R) and projection optics (PL) with a mark location detection means (52A, 52B). It is desirable that the location where detection of the predetermined reference point on a substrate stage (18) and the physical relationship based on [of a mask pattern image] projection is attained in the projection field of projection optics (PL) is defined as the 1st location in this case, and it is made to perform reset of the 1st and 2nd length measurement shaft in this location.
[0036] In each above-mentioned invention said each substrate stage (WS1, WS2) like invention according to claim 8 A stage body (WS1a, WS2a), It has the substrate attachment component (WS1b, WS2b) which is carried free [attachment and detachment] on this body (WS1a, WS2a), and holds a substrate. The reflector for interferometers is established in the side face of this substrate attachment component (WS1b, WS2b), and it is a reference mark (it WM(s)) as said reference point in the top face of said substrate attachment component. When RM) is formed, you may make it said migration means (20 22) move said substrate attachment component between said every place points instead of said substrate stage.
[0037] [in these cases] moreover, as a migration means Among 3 points of the 1st location, the 2nd location, and the 3rd location (or between the 1st location and the 2nd location) an interferometer measurement value -- **** for monitors -- as long as it moves a substrate stage or a substrate attachment

component without things, what kind of thing may be used, for example, the migration means may be constituted by the robot arm (20 22) like invention according to claim 9.
[0038] Moreover, in each above-mentioned invention, although the fixed mirror used as the criteria of length measurement of interferometer systems may be arranged anywhere, it may attach in said projection optics (PL) and said alignment system (WA) the fixed mirror (14X, 14Y, 18X, 18Y) which serves as criteria of length measurement by the interferometer, respectively like invention according to claim 10. In this case, compared with the case where a fixed mirror is in other locations, it is hard to produce an error in a length measurement result under the effect of location fluctuation of the fixed mirror resulting from location fluctuation of a fixed mirror with time or vibration of equipment.
[0039] In each above-mentioned invention, although only two, the 1st substrate stage and the 2nd substrate stage, were prepared, like invention according to claim 11, the induction substrate other than said 1st substrate stage (WS1) and the 2nd substrate stage (WS2) may be held, and these stages may prepare further at least one another, independently movable substrate stage for the inside of said two same flat surfaces as a substrate stage.
[0040]
[Embodiment of the Invention]
<< -- 1st operation gestalt>> -- the 1st operation gestalt of this invention is hereafter explained based on drawing 1 thru/or drawing 4 .
[0041] The configuration of the aligner 100 concerning the 1st operation gestalt is shown in drawing 1 . This aligner 100 is a contraction projection mold aligner (the so-called stepper) of a step-and-repeat method.
[0042] The reticle stage RST where this projection aligner 100 holds the reticle R as an illumination system IOP and a mask, The projection optics PL which projects the image of the pattern formed in Reticle R on the wafer W as an induction substrate Wafer W is held. A base 12 top as the movable 1st substrate stage in the secondary XY direction The interferometer systems 26 which hold the ** wafer stage WS 1 and Wafer W, and measure each location of the wafer stages WS1 and WS2 of 2 or 2 wafer stages WS as the movable 2nd substrate stage for a base 12 top in the XY two-dimensional direction independently in the wafer stage WS 1, It has the main control unit 28 grade as a control means which consists of the minicomputer (or microcomputer) constituted including CPU, ROM, RAM, an I/O interface, etc., and carries out generalization control of the whole equipment.
[0043] Said illumination system IOP consists of the light sources (a mercury lamp or excimer laser) and an illumination-light study system which consists of a fly eye lens, a relay lens, a condensing lens, etc. This illumination system IOP illuminates the pattern of the inferior surface of tongue (pattern formation side) of Reticle R by uniform illumination distribution by the illumination light IL for the exposure from the light source. Here, as illumination light IL for exposure, excimer laser light, such as the bright lines, such as i line of a mercury lamp, or KrF, ArF, etc. is used.
[0044] On the reticle stage RST, Reticle R is being fixed through a fixed means by which it does not illustrate, and the minute drive of this reticle stage RST is enabled by the non-illustrated drive system in X shaft orientations (the space rectangular cross direction in drawing 1), Y shaft orientations (space longitudinal direction in drawing 1), and the direction (hand of cut within XY side) of theta. Thereby, this reticle stage RST can position Reticle R now in the condition that the core (reticle center) of the pattern of Reticle R is mostly in agreement with the optical axis Ae of projection optics PL (reticle alignment). The condition that this reticle alignment was performed is shown by drawing 1 .
[0045] Projection optics PL is made into Z shaft orientations to which the migration side of a reticle stage RST and the optical axis Ae cross at right angles, and what is a both-sides tele cent rucksack here, and has the predetermined contraction scale factor beta (beta is 1/5) is used. For this reason, where alignment (alignment) of the pattern of Reticle R and the shot field on Wafer W is performed, if Reticle R is illuminated by the illumination light IL with a uniform illuminance, the pattern of a pattern formation side will be reduced by projection optics PL for the contraction scale factor beta, it will be projected on the wafer W with which the photoresist was applied, and the contraction image of a pattern will be formed in each shot field on Wafer W.
[0046] With this operation gestalt, moreover, in the side face by the side of the X shaft orientations 1 of projection optics PL (left-hand side in drawing 1) X fixed mirror 14X used as the criteria of X shaft-orientations location management at the time of exposure of the wafer stages WS1 and WS2 is fixed. Similarly in the side face by the side of the Y shaft orientations 1 of projection optics PL (space back side in drawing 1) Y fixed mirror 14Y used as the criteria of Y shaft-orientations location management at the time of exposure of the wafer stages WS1 and WS2 is being fixed (refer to drawing 3).

[0047] The non-illustrated gas hydrostatic bearing is prepared in the base of said wafer stages WS1 and WS2, respectively, and surfacing support of the wafer stages WS1 and WS2 is carried out by these gas hydrostatic bearings through the path clearance of several micron (micrometer) extent in the base 12 upper part, respectively between base 12 top faces. Mirror plane processing is performed to the field by the side of the X shaft orientations 1 of these wafer stages WS1 and WS2 (left-hand side in drawing 1), and the field by the side of the Y shaft orientations 1 (space back side in drawing 1), respectively, and the reflector which functions as a migration mirror for reflecting the length measurement beam from interferometer systems 26 is formed in them, respectively.
[0048] Moreover, the magnet is being fixed to the base of the wafer stages WS1 and WS2, respectively, and, as for the wafer stages WS1 and WS2, it moves in the XY two-dimensional direction in a base 12 top according to the electromagnetic force generated by the drive coil which is not illustrated [which was embedded in the predetermined range in the base (specifically the predetermined field near the projection optics PL lower part and the predetermined field near the alignment microscope WA lower part)]. That is, the so-called MUBINGU magnet type as a driving means of the wafer stages WS1 and WS2 of linear motor is constituted by the magnet of the wafer stage WS 1 and WS2 base, and the drive coil embedded in the base 12. The drive current of the drive coil of this linear motor is controlled by the main control unit 28.
[0049] On the wafer stages WS [WS1 and] 2, Wafer W is held by vacuum adsorption etc. through the non-illustrated wafer holder, respectively. Moreover, on these wafer stages WS [WS1 and] 2, the reference mark plates FM1 and FM2 with which the front face becomes the same height as the front face of Wafer W are being fixed, respectively. As shown in the top view of drawing 2 , the mark WM for measuring under the wafer alignment microscope WA later mentioned in that longitudinal direction center section is formed in the front face of one reference mark plate FM 1, and the mark RM of the pair used for relative location measurement with Reticle R through projection optics PL at the longitudinal direction both sides of this mark WM is formed in it. The completely same marks WM and RM also as this are formed also on the reference mark plate FM 2 of another side.
[0050] Furthermore, with this operation gestalt, the alignment microscope WA of the off-axis method as an alignment system which detects the mark for location detection (alignment mark) which was formed in the direction of about 45 degrees at predetermined distance, and was formed in the location distant 3000mm from projection optics PL to XY shaft at Wafer W is formed. The level difference is made to Wafer W by exposure to a front layer, and process processing, the mark for location detection for measuring the location of each shot field on a wafer (alignment mark) is also included in it, and this alignment mark is measured under the alignment microscope WA.
[0051] As an alignment microscope WA, the so-called alignment microscope of the FIA (field Image Alignment) system of an image-processing method is used here. According to this, after the illumination light emitted from the light source which is not illustrated [which emits broadband illumination light, such as a halogen lamp,] passes a non-illustrated objective lens, it irradiates on Wafer W (or the reference mark plate FM). The reflected light from the wafer mark field which is not illustrated [of the wafer W front face] carries out the sequential transparency of an objective lens and the non-illustrated index plate, and image formation of the image of a wafer mark and the image of the index on an index plate is carried out on image pick-up sides, such as non-illustrated CCD. The photo-electric-conversion signal of these images is processed by the digital disposal circuit which is not illustrated in the signal-processing unit 16, the relative position of a wafer mark and an index is computed by the non-illustrated arithmetic circuit, and this relative position is told to a main control unit 28. In a main control unit 28, the location of the alignment mark on Wafer W is computed based on this relative position and the measurement value of interferometer systems 26.
[0052] moreover, in the side face by the side of the X shaft orientations 1 of the alignment microscope WA (left-hand side in drawing 1) X fixed mirror 18X used as the criteria of X shaft-orientations location management at the time of alignment actuation of the wafer stages WS1 and WS2 is fixed. Y fixed mirror 18Y used as the criteria of Y shaft-orientations location management at the time of exposure actuation of the wafer stages WS1 and WS2 is being similarly fixed to the side face by the side of the Y shaft orientations 1 of the alignment microscope WA (space back side in drawing 1).
[0053] In addition, as an alignment microscope, it is not only a FIA system but LIA (Laser Interferometric Alignment). Other optical alignment systems, such as a system and a LSA (Laser Step Alignment) system, of course Other optical equipments, such as a phase-contrast microscope and a differential interference microscope, STM (Scanning Tunnel Microscope: scanning tunneling microscope) which detects the irregularity of the atomic level on the front face of a sample using the tunnel effect, and the force between

atoms (attraction and repulsive force) are used. It is also possible to use non-optical equipments, such as AFM (Atomic Force Microscope: atomic force microscope) which detects the irregularity of the atomic molecule level on the front face of a sample, etc.

[0054] Furthermore, in the projection aligner 100 of this operation gestalt, the reticle alignment microscopes 52A and 52B as a mark location detection means for observing the image of reference mark RM on the reference mark plate FM through projection optics PL and the reticle alignment mark on Reticle R (illustration abbreviation) to coincidence are formed above Reticle R. The detecting signals S1 and S2 of the reticle alignment microscopes 52A and 52B are supplied to a main control unit 28. In this case, unitization of the deviation mirrors 54A and 54B for leading the detection light from Reticle R to the reticle alignment microscopes 52A and 52B, respectively is carried out to each reticle alignment microscopes 52A and 52B concerned in one, and the microscope units 56A and 56B of a pair are constituted. Initiation of an exposure sequence evacuates these microscope units 56A and 56B to the location which is not applied to a reticle pattern side with the mirror driving gear which is not illustrated by the command from a main control unit 28.

[0055] Next, the interferometer systems 26 of drawing 1 which manages the location of the wafer stages WS1 and WS2 are explained in full detail.

[0056] As shown in drawing 3 , in fact these interferometer systems 26 1st laser interferometer 26Xe for X shaft-orientations location measurement, Although constituted including 2nd [for Y shaft-orientations location measurement] laser interferometer 26Ye, 3rd laser interferometer 26Xa for X shaft-orientations location measurement, and 4th laser interferometer 26Ya for Y shaft-orientations location measurement, in drawing 1 , these are typically illustrated as interferometer systems 26.

[0057] While 1st laser interferometer 26Xe projects the reference beam Xe 1 of X shaft orientations which pass along the projection core of projection optics PL to X fixed mirror 14X The length measurement beam Xe 2 is projected to the reflector of a wafer stage (WS1 or WS2), and the variation rate of the wafer stage reflector over fixed mirror 14X is measured based on the interference condition that the reflected light of these two beams was made to pile up and interfere in one.

[0058] Moreover, while 2nd laser interferometer 26Ye projects the reference beam Ye1 of Y shaft orientations which pass along the projection core of projection optics PL to Y fixed mirror 14Y The length measurement beam Ye2 is projected to the reflector of a wafer stage (WS1 or WS2), and the variation rate of the wafer stage reflector over fixed mirror 14Y is measured based on the interference condition that the reflected light of these two beams was made to pile up and interfere in one.

[0059] Moreover, while 3rd laser interferometer 26Xa projects the reference beam Xa1 of X shaft orientations which pass along the detection core of the alignment microscope WA to X fixed mirror 18X The length measurement beam Xa2 is projected to the reflector of a wafer stage (WS1 or WS2), and the variation rate of the wafer stage reflector over fixed mirror 18X is measured based on the interference condition that the reflected light of these two beams was made to pile up and interfere in one.

[0060] Moreover, while 4th laser interferometer 26Ya projects the reference beam Ya1 of Y shaft orientations which pass along the detection core of the alignment microscope WA to Y fixed mirror 18Y The length measurement beam Ya2 is projected to the reflector of a wafer stage (WS1 or WS2), and the variation rate of the wafer stage reflector over fixed mirror 18Y is measured based on the interference condition that the reflected light of these two beams was made to pile up and interfere in one.

[0061] The length measurement shaft of 1st laser interferometer 26Xe which consists of the reference beam Xe 1 and the length measurement beam Xe 2 here The 1st length measurement shaft Xe The 2nd length measurement shaft of laser interferometer 26Ye which consists of the reference beam Ye1 and the length measurement beam Ye2 The 2nd length measurement shaft Ye, The 3rd length measurement shaft of laser interferometer 26Xa which consists of the reference beam Xa1 and the length measurement beam Xa2 The 3rd length measurement shaft Xa, When the 4th length measurement shaft of laser interferometer 26Ya which consists of the reference beam Ya1 and the length measurement beam Ya2 shall be called the 4th length measurement shaft Ya, the 1st length measurement shaft Xe and the 2nd length measurement shaft Ye Focusing on projection of projection optics PL (an optical-axis Ae core and coincidence), it crosses perpendicularly, and the 3rd length measurement shaft Xa and the 4th length measurement shaft Ya cross perpendicularly focusing on detection of the alignment microscope WA. The location of a wafer stage can be correctly measured by each measurement shaft orientations, without influencing this of the Abbe error by yawing of a wafer stage etc. at the time of measurement of the mark for location detection on Wafer W (alignment mark), and exposure of the pattern to Wafer W top so that it may mention later. In addition, it is much more desirable as the above 1st thru/or the 4th laser interferometer to use the heterodyne

interferometer of two frequencies in order to raise the accuracy of measurement.
[0062] The measurement value of return and interferometer systems 26 is supplied to drawing 1 at a main control unit 28, and in a main control unit 28, position control of the wafer stages WS1 and WS2 is carried out through the linear motor mentioned above, carrying out the monitor of the measurement value of these interferometer systems 26.
[0063] While exposure of the reticle pattern which minded projection optics PL to the wafer W on the wafer stages [WS / WS and / 2] 1 is performed in the case of the operation gestalt of **** 1 so that clearly also from drawing 3 The location of a wafer stage is managed by the 1st, 2nd laser interferometer 26Xe, and 26Ye. While measurement of the mark for location detection on Wafer W (alignment mark) is performed by the alignment microscope WA, the location of a wafer stage is managed by 3rd and 4th laser interferometer 26Xa and 26Ya. However, since each length measurement shaft stops hitting the reflector of each wafer stage after exposure is completed, or after measurement of an alignment mark is completed, location management of the wafer stage by interferometer systems 26 becomes difficult.
[0064] for this reason, in the projection aligner 100 of this operation gestalt The 3rd location shown by the imaginary line in drawing 3 in the wafer stage WS 1, and the 2nd location shown as a continuous line in drawing 3 , The 1st robot arm 20 as a migration means to which it is made to move free among 3 points with the 1st location in which the wafer stage WS 2 is located in drawing 3 , The 2nd robot arm 22 as a migration means to which the wafer stage WS 2 is similarly moved free among 3 points of the 1st location of the above, the 2nd location, and the 3rd location is formed. These [1st] and the 2nd robot arm 20 and 22 are also controlled by the main control unit 28, and the position control precision of the wafer stage of these [1st] and the 2nd robot arm 20 and 22 has become about **1 micrometer in general. In order to realize the above-mentioned position control precision certainly, it combines a vertical-movement pin as shown with Signs 24A and 24B in drawing 3 as a stopper, and you may make it prepare it, although detailed explanation is omitted since the owner articulated robot arm of a well-known configuration is used as these robot arms 20 and 22.
[0065] When the 3rd location, the 2nd location, and the 1st location are explained briefly, here with the 3rd location The wafer exchange location in which delivery of Wafer W is performed between the conveyance arms 50 and wafer stages (WS1, WS2) which constitute a part of external substrate conveyance device is meant. The 2nd location After loading of Wafer W is completed, the location of arbitration where it is the location where alignment is performed to the wafer W on a wafer stage, and both the 3rd length measurement shaft Xa and the 4th length measurement shaft Ya hit the reflector of a wafer stage is meant. The 1st location means the location of arbitration where it is the location where exposure is performed to the wafer W on a wafer stage, and both the 1st length measurement shaft Xe and the 2nd length measurement shaft Ye hit the reflector of a wafer stage, after the alignment of a wafer is completed.
[0066] As mentioned above, with this operation gestalt, the location shown in drawing 3 shall be defined as the 1st location, the 2nd location, and the 3rd location, respectively, but the 2nd location is good also considering the location where what kind of location may be defined, for example, the mark WM on the reference mark plate FM becomes in the detection field of the alignment microscope WA as the 2nd location, if the above-mentioned definition satisfies. Similarly, the 1st location is also good also considering the location where what kind of location may be defined, for example, the mark RM on the reference mark plate FM becomes in the projection field of projection optics PL as the 1st location, if the above-mentioned definition is satisfied.
[0067] Next, the flow of overall actuation of the projection aligner 100 of this operation gestalt constituted as mentioned above is explained.
[0068] ** As a premise, the wafer stage WS 1 shall be located in the 3rd location, and the wafer stage WS 2 shall be located in the 1st location.
[0069] First, wafer exchange is performed between the wafer stage WS 1 and the conveyance arm 50. detailed, since this wafer exchange is performed by the pin center,large rise on the wafer stage WS 1 (wafer rise device), and the conveyance arm 50 as usual here -- it explains -- although it ******, since the positioning accuracy of a robot arm is **1 or less um in general as stated previously, also let positioning accuracy of the conveyance arm 50 be a thing almost comparable as this. In advance of this wafer exchange, outline positioning is made in X, Y, and the direction of theta by non-illustrated PURIARAIMENTO equipment, and, as for Wafer W, the load location to a wafer stage top does not shift greatly, for example, the load location of the wafer W to the reference mark plate FM 1 has also become in the error range of **1 or less above um.
[0070] During this wafer exchange, although the location is not managed with a laser interferometer, since

the 1st robot arm 20 has caught the wafer stage WS 1, the wafer stage WS 1 does not produce un-arranging [of going to the place where the wafer stage WS 1 is selfish]. In addition, while being caught by the 1st robot arm 20, the linear motor which drives the wafer stage WS 1 shall have stopped (it is the same as below).
[0071] After wafer exchange (loading of the wafer W to the wafer stage WS 1 top) is completed, in a main control unit 28, the 1st robot arm 20 is controlled, the wafer stage WS 1 is moved to the 2nd location shown as a continuous line in drawing 3 , and 3rd and 4th laser interferometer 26Xa and 26Ya are reset to coincidence in this location. since the 1st robot arm 20 finishes a duty here after this reset is completed -- this -- the 1st robot arm 20 shunts in the location which leaves the wafer stage WS 1 by the non-illustrated drive system according to the directions from a main control unit 28, and does not become obstructive.
[0072] With a main control unit 28, position control is carried out through the linear motor which mentioned the wafer stage WS 1 above so that the mark WM on the reference mark plate FM 1 on the wafer stage WS 1 might be positioned in the detection field of the alignment microscope WA after above 3rd and 4th laser interferometer 26Xa and reset termination of 26Ya, carrying out the monitor of the measurement value of interferometer 26Xa and 26Ya. The positioning accuracy to the 2nd location by the 1st robot arm 20 here Since **1 or less um is possible in general and the interferometer length measurement shaft is reset like the above-mentioned in this 2nd location Based on a design value (relative-position relation on a design with the reflector of the wafer stage WS 1, and the mark WM on a reference mark plate), position control is possible at the resolving power of about 0.01 micrometers after that. As a result, the wafer stage WS 1 is positioned in precision sufficient for the mark WM measurement under the alignment microscope WA. In addition, when the mark WM on the reference mark plate FM 1 on the wafer stage WS 1 sets the 2nd location as the location positioned in the detection field of the alignment microscope WA, since migration of the wafer stage WS 1 after the above-mentioned interferometer reset is unnecessary, it is much more desirable in respect of a throughput.
[0073] Next, under the alignment microscope WA, the location (deltaWX and deltaWY) of the mark WM on the reference mark plate FM 1 on the basis of the detection core (index core) of this alignment microscope WA is measured, and the average (X0 and Y0) of 3rd [under this measurement] and 4th laser interferometer 26Xa and the measurement value of 26Ya is calculated in a main control unit 28. When the measurement value of laser interferometer 26Xa and 26Ya shows (X0-deltaWX and Y0-deltaWY) by this, it turns out that the mark WM on the reference mark plate FM 1 is just under the detection core (index core) of the alignment microscope WA. A series of actuation after above 3rd and 4th laser interferometer 26Xa and reset of 26Ya shall be called W-SET to below.
[0074] Thus, while wafer exchange, interferometer reset, and a series of actuation of W-SET are performed on one wafer stage WS 1, the following actuation is performed on the wafer stage WS 2 of another side.
[0075] That is, the wafer stage WS 2 is moved to the 1st location by the 2nd robot arm 22 like the above-mentioned, and point-to-point control to this 1st location is also performed in the precision of **1 or less um. In a main control unit 28, the 1st, 2nd laser interferometer 26Xe, and 26Ye are reset at the same time migration of the wafer stage WS 2 in this 1st location is completed.
[0076] since the 2nd robot arm 22 finishes a duty here after reset of this 1st [the], 2nd laser interferometer 26Xe, and 26Ye is completed -- this -- the 2nd robot arm shunts in the location which leaves the wafer stage WS 2 by the non-illustrated drive system according to the directions from a main control unit 28, and does not become obstructive.
[0077] Next, the location of the wafer stage WS 2 is controlled by the main control unit 28 through a linear motor to be positioned in the location where the mark RM on the reference mark plate FM 2 laps with the reticle alignment mark (illustration abbreviation) currently formed in Reticle R through projection optics in the projection field of projection optics PL, carrying out the monitor of the measurement value of laser interferometer 26Xe and 26Ye. In this case, the positioning accuracy to the 1st location by the 2nd robot arm 22 Since **1 or less um is possible in general and the interferometer length measurement shaft is reset like the above-mentioned in this 1st location Based on a design value (relative-position relation on a design with the reflector of the wafer stage WS 2, and the mark RM on the reference mark plate FM 2), position control is possible at the resolving power of about 0.01 micrometers after that. As a result, the wafer stage WS 2 is positioned under the reticle alignment microscopes 52A and 52B in sufficient precision required to observe a reticle alignment mark and the mark RM on the reference mark plate FM to coincidence.
[0078] Under the reticle alignment microscopes 52A and 52B, next, relative spacing of the reticle alignment mark on Reticle R, and the mark RM on the reference mark plate FM 2 (delta RX, delta RY), Namely, the location gap (deltaRX and deltaRY) with the reference mark RM core which is an origin/datum on the wafer

stage WS 2 to the projection core of the pattern image of the reticle R as a predetermined origin/datum in the projection field of projection optics PL is measured. In a main control unit 28, the measurement value (X1 and Y1) of laser interferometer 26Xe at that time and 26Ye is read at the same time it incorporates the measurement value of these reticle alignment microscopes 52A and 52B. Thereby, it turns out that the location where the measurement value of laser interferometer 26Xe and 26Ye serves as (X1-deltaRX, Y1-deltaRY) is a location with which a reticle alignment mark and the mark RM on the reference mark plate FM 2 lap through projection optics PL exactly. A series of actuation after reset of the above 1st, 2nd laser interferometer 26Xe, and 26Ye shall be called R-SET to below.
[0079] ** Next, wafer alignment by the side of the wafer stage WS 1 and exposure by the side of the wafer stage WS 2 are performed in parallel.
[0080] Namely, after 3rd [which was mentioned above] and 4th laser interferometer 26Xa and reset of 26Ya The location of the wafer stage WS 1 is managed based on the measurement value of laser interferometer 26Xa and 26Ya. Measurement of the mark (alignment mark) location for location detection of the specific sample shot beforehand defined among two or more shot fields on Wafer W in the main control unit 28 Sequential migration of the wafer stage WS 1 is carried out through a linear motor, carrying out the monitor of the measurement value of interferometer 26Ya and 26Xa, and it carries out on system of coordinates (Xa, Ya) based on the output of the alignment microscope WA. In this case, since the measurement value (X0-deltaX and Y0-deltaY) of an interferometer in case the mark WM on the reference mark plate FM 1 comes just under the detection core of the alignment microscope WA can be found, In order to position each alignment mark on Wafer W in the detection field of the wafer alignment microscope WA based on this value and the design value of the relative position of a reference mark WA and each alignment mark, laser interferometer 26Ya, It is called for by the operation whether the measurement value of 26Xa(s) should just move the wafer stage WS 1 to the location which shows which value, and sequential migration of the wafer stage WS 1 is carried out based on this result of an operation.
[0081] Although it is sufficient for the alignment of X, Y, and theta of Wafer W if two X measurement marks and one Y measurement mark (or one X measurement mark and two Y measurement marks) are measured also at the lowest, measurement of three or more X measurement marks which are not on a straight line, and three or more Y measurement marks which are not on a straight line shall be performed as an EGA sample shot here.
[0082] And the statistics operation by least square method which is indicated by JP,61-44429,A etc. is performed using the alignment mark (wafer mark) location of each of this measured sample shot, and the array data of the shot field on a design, and it asks for all the array data of the above-mentioned two or more shot field on Wafer W. However, as for a count result, it is desirable to take the value (X0-deltaX and Y0-deltaY) and difference of an interferometer when the mark WM on the reference mark plate FM 1 for which it asked previously comes directly under the detection core of the alignment microscope WA, and to change into the data on the basis of the reference mark WA on the reference mark plate FM 1. Thereby, the relative physical relationship of the mark WM on the reference mark plate FM 1 and the reference point of each shot field on Wafer W makes it the need, and is fully known.
[0083] Thus, in parallel to fine alignment (EGA) being performed by the wafer stage WS 1 side, superposition exposure with the pattern image of Reticle R and the established pattern of the shot field on Wafer W is performed as follows by the wafer stage WS 2 side.
[0084] Namely, the measurement result of the location gap error above-mentioned in a main control unit 28 and the coordinate location of the wafer stage WS 2 at that time (Xe, Ye), It is based on the array coordinate data of each shot on the basis of the reference mark WA on the reference mark plate FM 2 currently beforehand computed like the above by alignment actuation. Sequential exposure of the reticle pattern is carried out on Wafer W by the step-and-repeat method, carrying out closing motion control of the shutter in an illumination-light study system positioning each shot field on Wafer W in an exposure location carrying out the monitor of the measurement value of interferometer 26Ye and 26Xe. The exposure to the wafer W on the wafer stage WS 2 is preceded here. In spite of having reset interferometer 26Xe and 26Ye (the length measurement shaft of an interferometer having once run out) When the reason in which highly precise superposition is possible is explained in full detail, spacing of the mark WM on the reference mark plate FM 2 and Mark RM is known. The relative physical relationship of the mark WM on the reference mark plate FM 2 and the reference point of each shot field on Wafer W is computed like the above-mentioned by the fine alignment (EGA) performed in advance of this. [where / on Reticle R / the reticle alignment mark on Reticle R exists, and] Since (namely, relative-position relation with the mark RM which are the projection core (it is mostly in agreement with the projection core of projection optics PL) of the pattern image of the

reticle which is a predetermined origin/datum in the projection field of projection optics PL, and an origin/datum on the wafer stage WS 2) is measured, it is based on these measurement results. It is because it is clear whether wafer W top each shot field laps with the pattern image of Reticle R exactly if the measurement value of the 1st, 2nd laser interferometer 26Xe, and 26Ye turns into which value.
[0085] ** After fine alignment (EGA) is completed by the wafer stage WS 1 side as mentioned above and the exposure of a reticle pattern to all the shot fields on Wafer W is completed by the wafer stage WS 2 side, move the wafer stage WS 1 to the 1st location of the lower part of projection optics PL, and move the wafer stage WS 2 to the 3rd location which is a wafer exchange location.
[0086] That is, the wafer stage WS 1 is caught by the 1st robot arm 20 according to the directions from a main control unit 28, and is moved to the 1st location. Point-to-point control to this 1st location is also performed in the precision of **1 or less um. In a main control unit 28, the 1st, 2nd laser interferometer 26Xe, and 26Ye are reset at the same time migration of the wafer stage WS 1 in this 1st location is completed.
[0087] since the 1st robot arm 20 finishes a duty here after this reset is completed -- this -- the 1st robot arm 20 shunts in the location which leaves the wafer stage WS 1 by the non-illustrated drive system according to the directions from a main control unit 28, and does not become obstructive.
[0088] Next, in a main control unit 28, R-SET is performed like the wafer stage WS 2 side described previously. By this Relative spacing of a reticle alignment mark and the mark RM on the reference mark plate FM 1 (deltaRX and deltaRY), namely, as a predetermined reference point in the projection field of projection optics PL The stage coordinate location (X1 and Y1) at the time of the location gap (deltaRX and deltaRY) with the reference mark RM core which is a reference point on the wafer stage WS 2 to the projection core of the pattern image of the ** reticle R, and this location gap measurement is measured.
[0089] While interferometer reset and R-SET are performed as mentioned above by the wafer stage WS 1 side According to the directions from a main control unit 28, the 2nd robot arm 22 catches the wafer stage WS 2 which exposure actuation ended. The wafer stage WS 2 is moved to a wafer delivery location (the 3rd location) for wafer exchange, and wafer exchange, interferometer reset, and W-SET are performed like the wafer stage WS 1 side mentioned above after that.
[0090] ** Subsequently, like the above-mentioned, in parallel to sequential exposure of the reticle pattern being carried out on Wafer W by the step-and-repeat method by the wafer stage WS 1 side, control actuation of both stages by the main control unit 28 so that fine alignment (EGA) is performed by the wafer stage WS 2 side.
[0091] ** Actuation of the actuation [of both the stages WS1 and WS2], 1st, and 2nd robot arm is controlled by the main control unit 28 so that actuation of ** explained until now - ** is repeated successively after that.
[0092] The flow of carrying-out on both [which was explained above] stages WS [WS1 and] 2 parallel operation is shown in drawing 4 .
[0093] Since exposure actuation by the side of one stage of the wafer stage WS 1 and the wafer stages WS 2 and fine alignment actuation by the side of the stage of another side can be performed in parallel according to the projection aligner 100 concerning the operation gestalt of **** 1 as explained above, compared with wafer exchange (search alignment is included), fine alignment, and the conventional technique in which exposure was performed sequentially, the large improvement in a throughput is expectable. Usually, in an exposure processing sequence, it is because the rate of the time amount which fine alignment actuation and exposure actuation take is large.
[0094] Since it is premised on the length measurement shaft of interferometer systems 26 going out according to the above-mentioned operation gestalt, moreover, the die length of the reflector (when using a migration mirror, it is this migration mirror) of each wafer stage It comes out enough with extent slightly longer than a wafer diameter, and from a certain thing, compared with the conventional technique on condition of a length measurement shaft not going out, small and lightweight-izing of a wafer stage are possible, and, thereby, improvement in stage controllability ability is expected.
[0095] Furthermore, since the mark location on the reference mark plate FM on a stage is measured in each exposure forward before alignment with the above-mentioned operation gestalt on the assumption that the length measurement shaft of interferometer systems goes out However long the projection core of projection optics PL and the pitch (the amount of base lines) based on [of the alignment microscope WA] detection may become, especially un-arranging does not have it, and it somewhat fully detaches spacing of projection optics PL and the alignment microscope WA. Wafer alignment and exposure can be performed in parallel in time, without the wafer stage WS 1 and the wafer stage WS 2 producing interference etc.

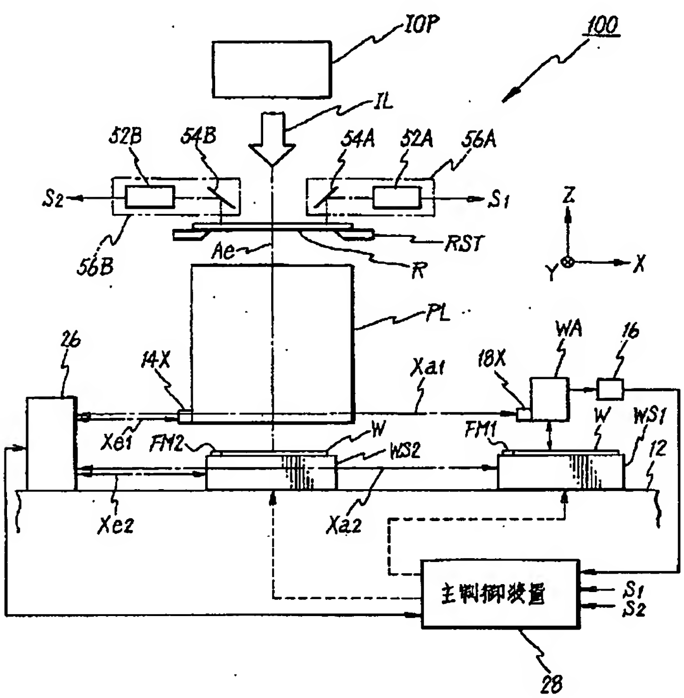
[0096] Moreover, with the above-mentioned operation gestalt, since interferometer systems 26 are equipped with the 1st length measurement shaft Xe which crosses perpendicularly focusing on projection of projection optics PL, the 2nd length measurement shaft Ye, and the 3rd length measurement shaft Xa and the 4th length measurement shaft Ya which crosses perpendicularly focusing on detection of the alignment microscope WA, the two-dimensional location of a wafer stage is correctly manageable at the time of any at the time of alignment actuation and exposure.
[0097] In addition, since the fixed mirrors 14X, 14Y, 18X, and 18Y for interferometers were fixed to the side face of projection optics PL, and the side face of the alignment microscope WA, as long as there is no fluctuation of a fixed mirror location during alignment measurement and exposure, even if it changes a fixed mirror location by a change with time, vibration of equipment, etc., un-arranging [of the position control precision of a wafer stage falling by this fluctuation] will not arise. Even if it follows, for example, makes the alignment microscope WA the configuration which can move up and down, it does not produce any un-arranging, either.
[0098] In addition, although the operation gestalt of the above 1st explained the case where the wafer stage WS 1 and the wafer stage WS 2 were moved among 3 points of the 1st location, the 2nd location, and the 3rd location, by the 1st and 2nd robot arm 20 and 22 When this invention does not make it limit to this and is [for example,] made to perform wafer exchange in the 2nd location, you may make it move the wafer stage WS 1 and the wafer stage WS 2 between the 1st location and the 2nd location by the 1st and 2nd robot arm 20 and 22. In this case, after controlling actuation of both stages by the main control unit 28 so that exposure actuation of the wafer W on one stage of the wafer stage WS 1 and the wafer stages WS 2 and alignment actuation of the wafer W on the stage of another side are performed in parallel, the location of both stages will be replaced by the 1st and 2nd robot arm 20 and 22.
[0099] Moreover, although the operation gestalt of the above 1st explained the case where exposure of a step-and-repeat method was performed to the wafer W on a stage based on EGA measurement, projection exposure of the pattern image of a reticle may be carried out one by one to each shot field on Wafer W, repeating alignment and exposure not only with this but with a die Bayh die. Since the relative position of each alignment mark to the mark WM formed in the reference mark plate FM on a stage at the time of alignment is measured even if it is this case, based on this relative position, a reticle pattern image can be laid on top of each shot field like the above. As for this die Bayh die method, it is desirable to adopt, when there are few shot fields on Wafer W. It is more desirable to be based on EGA considered and mentioned above from a viewpoint which prevents the fall of a throughput, when there are many shot fields.
[0100] With the operation gestalt of the above 1st, the 1st robot arm 20 one stage WS 1 Moreover, the 1st location, Although the case where made it move among 3 points of the 2nd location and the 3rd location, and the 2nd robot arm 22 moved the stage WS 2 of another side among 3 points of the 1st location, the 2nd location, and the 3rd location was explained As this invention is not limited to this, for example, one robot arm 20 carries a stage WS 1 (or WS2) from the 1st location to the 3rd location, the 1st location, When it carries and releases to the location which is other than the 2nd location and the 3rd location and the robot arm 22 of another side adopts the method of moving this stage WS 1 (or WS2) from this location to the 3rd location It is also possible to make one robot arm 20 only into for [of the 2nd location of both stages and the 1st location] conveyances, and to make the robot arm 2 of another side only into for [of the 3rd location of both stages and the 2nd location] conveyances.
[0101] Moreover, you may make it measure X of a wafer stage, and not only the advancing-side-by-side location of Y but yawing and pitching, using the interferometer of a multiple spindle as each laser interferometer which constitutes interferometer systems 26.
[0102] << -- 2nd operation gestalt>> -- next, the 2nd operation gestalt of this invention is explained based on drawing 5 . Here, about a component the same as that of the 1st operation gestalt mentioned above, or equivalent, while using the same sign, the explanation shall be omitted.
[0103] It has the description at the point that this 2nd operation gestalt is constituted disengageable by two parts with substrate attachment component WS1b of the same configuration with the wafer stage WS 1 removable on stage body WS1a and this stage body WS1a, and the wafer stage WS 2 is constituted disengageable similarly at two parts of stage body WS2a and substrate attachment component WS2b of the same configuration removable on this stage body WS2a.
[0104] While adsorption maintenance of the wafer W is carried out through the non-illustrated wafer holder at substrate attachment component WS1b and WS2b, the reflector which functions as a migration mirror for interferometers is formed in the side face, respectively. Moreover, the reference mark plates FM1 and FM2 are formed in the top face at such substrate attachment component WS1b and WS2b, respectively.

[0105] Although parallel processing is performed on the wafer stages WS [WS1 and] 2 almost like the 1st gestalt mentioned above with the operation gestalt of **** 2 When alignment actuation is completed by one stage side and exposure actuation is completed by the stage side of another side The 1st and 2nd robot arm 20 and 22 is controlled by the main control unit 28. Are concurrent with being conveyed on stage body WS2a which substrate attachment component WS1b by the side of the stage which alignment actuation ended (or WS2b) has stopped in the 1st location (migration). Substrate attachment component WS2b by the side of the stage which exposure ended (or WS1b) is conveyed on stage body WS1a stopped in the 2nd location, it does in this way, and exchange of substrate attachment component WS1b and WS2b is performed. Since location management of the wafer stages WS1 and WS2 becomes impossible in order that the length measurement shaft of interferometer systems 26 may go out in case it is exchanged in substrate attachment component WS1b and WS2b, the stage stoppers 30a and 30b come out, and both stage body WS1a and WS2a are held in the location in the meantime. In this case, wafer exchange is performed by the non-illustrated conveyance arm in the 2nd location.
[0106] Here so that it may be easily imagined from drawing 5 with the operation gestalt of **** 2 As the 2nd location, the location where the mark WM on the reference mark plate FM becomes in the detection field of the alignment microscope WA as the 1st location The location where the mark RM on the reference mark plate FM becomes in the projection field of projection optics PL is defined, respectively. Therefore, the reset and R-SET, or W-SET of a length measurement shaft of interferometer systems 26 will be performed by the main control unit 28 with migration of a up to [the stage body of substrate attachment component WS1b and WS2b].
[0107] Also according to this 2nd operation gestalt, effectiveness equivalent to the 1st operation gestalt mentioned above can be acquired.
[0108] In addition, although the operation gestalt of the above 2nd explained the case where the 1st and 2nd robot arm 20 and 22 moved a substrate attachment component between the 1st location and the 2nd location You may make it the 1st and 2nd robot arm 20 and 22 move a substrate attachment component among 3 points of the 1st location, the 2nd location, and the 3rd location like the 1st operation gestalt mentioned above. In this case, since wafer exchange can be performed in a place unrelated to projection optics PL and the alignment microscope WA, even if it is the case that the working distance of an alignment microscope WA lower part is narrow, there is no un-arranging -- the alignment microscope WA becomes the failure of wafer exchange -- for example.
[0109] In addition, although the above 1st and the 2nd operation gestalt explained the case where a robot arm and a so-called stage stopper were used, as a cure at the time of the length measurement shaft of interferometer systems 26 once going out The 2-dimensional grating is minced for example, not only on this but on the wafer stage inferior surface of tongue. A location may be read in under a stage run side with an optical encoder. As long as it can hold stopping a means by which a stage can be correctly moved to the location of a degree after the interferometer length measurement shaft has once gone out, or a stage body, by the position, what kind of means may be used.
[0110] Moreover, although the above 1st and the 2nd operation gestalt explained the case where two wafer stages where it moves independently were prepared, three or more wafer stages where it moves independently may be prepared. When three wafer stages are prepared, for example, exposure actuation, alignment actuation, and wafer display flatness measurement actuation can be performed in parallel. Moreover, two or more projection optics PL and alignment microscopes WA may be formed. When there is two or more projection optics, exposure actuation of two kinds of different patterns from alignment actuation can be performed in concurrency, and it is suitable for the so-called double exposure etc.
[0111] Furthermore, although the case where this invention was applied to the projection aligner of a step-and-repeat method was illustrated with the above-mentioned operation gestalt, the applicability of this invention is not limited to this, and, of course in addition to this, this invention can apply the projection aligner of so-called step - and - scanning method to other aligners, such as for example, electron beam direct writing equipment.
[0112]
[Effect of the Invention] As explained above, while being able to raise a throughput according to invention according to claim 1, the outstanding exposure approach which is not in the former that the magnitude of a substrate stage can be defined regardless of the amount of base lines is offered.
[0113] Moreover, according to invention given in claim 2 thru/or 11, it is effective in the ability to raise a throughput by carrying out parallel processing of the exposure actuation on one substrate stage, and the alignment actuation on the stage of another side.

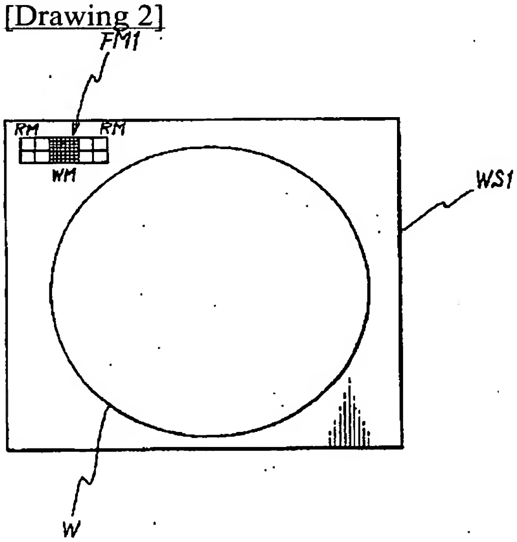
[Translation done.]

DRAWINGS

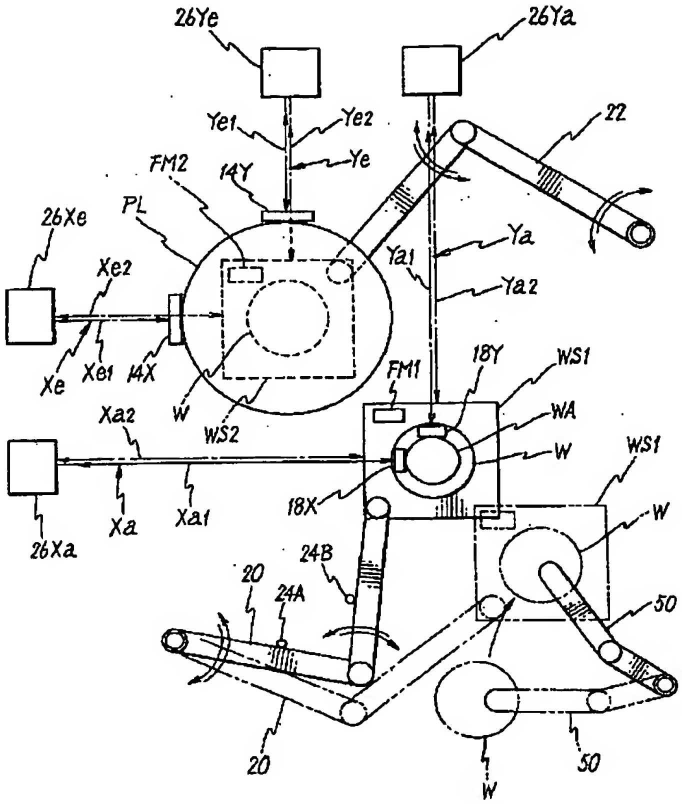
[Drawing 1]



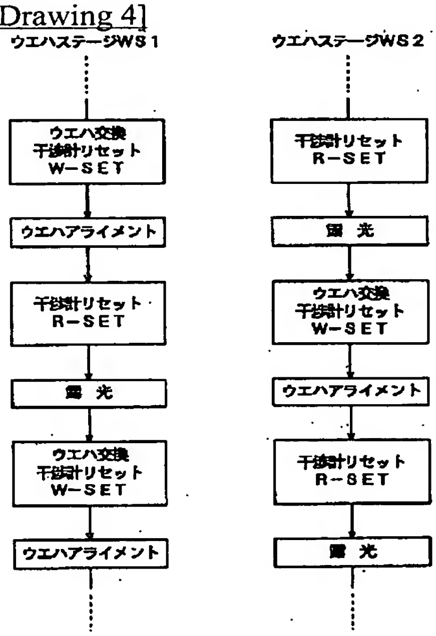
[Drawing 2]



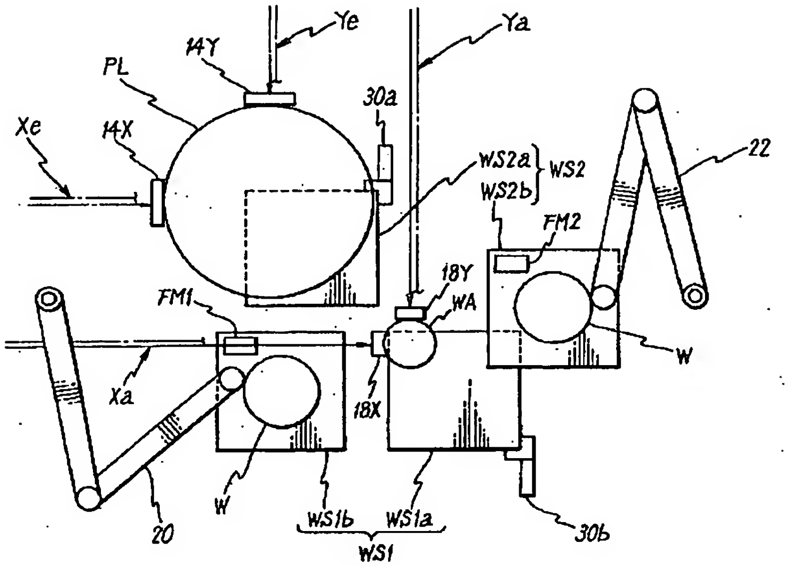
[Drawing 3]



[Drawing 4]



[Drawing 5]



[Translation done.]

* NOTICES *

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1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

CORRECTION OR AMENDMENT

[Kind of official gazette] Printing of amendment by the convention of 2 of Article 17 of Patent Law
[Section partition] The 2nd partition of the 7th section
[Publication date] August 11, Heisei 17 (2005. 8.11)

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[Application number] Japanese Patent Application No. 8-332846
[The 7th edition of International Patent Classification]

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H01L 21/027
G03F  7/20
G03F  9/00
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[FI]

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H01L 21/30    516 B
G03F  7/20    521
G03F  9/00        H
H01L 21/30    515 G
H01L 21/30    525 A
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[Procedure revision]
[Filing Date] January 19, Heisei 17 (2005. 1.19)
[Procedure amendment 1]
[Document to be Amended] Specification
[Item(s) to be Amended] Claim
[Method of Amendment] Modification
[The contents of amendment]
[Claim(s)]
[Claim 1]
It is the exposure approach which exposes the image of the pattern formed in the mask on an induction substrate through projection optics,
An induction substrate is held and two independently movable substrate stages are respectively prepared for the inside of the same flat surface,
The pattern image of said mask is exposed through said projection optics on the induction substrate held on one substrate stage of said two substrate stages,
During exposure of the induction substrate held on one [said] substrate stage, the physical relationship of the alignment mark on the induction substrate held on the substrate stage of another side of said two substrate stages and the reference point on the stage of said another side is measured,
Where the reference point on the substrate stage of said another side is positioned in the projection field of said projection optics after exposure termination of the induction substrate held on one [said] substrate stage, the coordinate location of a location gap of the reference point on the substrate stage of said another side to the predetermined reference point in the projection field and the substrate stage of said another side is detected,
The exposure approach characterized by performing alignment of the induction substrate which controlled migration of the substrate stage of said another side based on said detected physical relationship, said

detected location gap, and said detected coordinate location, and was held on the stage of said another side, and the pattern image of said mask.
[Claim 2]
It is the aligner which exposes a pattern on an induction substrate through projection optics,
An induction substrate is held and it is the movable 1st substrate stage about the inside of a two-dimensional flat surface.;
Holding an induction substrate, said 1st substrate stage is the independently movable 2nd substrate stage about the inside of the same flat surface as said 1st substrate stage.;
Alignment system for detecting the mark on the induction substrate which was formed apart from said projection optics and held on said substrate stage or on this stage;
Interferometer systems for measuring the two-dimensional location of said 1st substrate stage and the 2nd substrate stage, respectively;
Migration means to which each of said two substrate stages is moved between the 2nd predetermined location in the stage successive range at the time of the alignment to which mark detection on the induction substrate held by the 1st predetermined location and said predetermined alignment system in the stage successive range at the time of the exposure to which exposure is performed through said projection optics to the induction substrate held on this stage on a stage or on this stage is carried out;
While the induction substrate held on one stage of said 1st substrate stage and the 2nd substrate stages is exposed So that mark detection actuation by said alignment system may be performed on the stage of another side of said 1st substrate stage and the 2nd substrate stages The aligner which has the control means which controls said migration means and replaces the location of one [said] substrate stage and the substrate stage of another side after controlling actuation of said two stages, carrying out the monitor of the measurement value of said interferometer systems.
[Claim 3]
Said interferometer systems are equipped with the 1st length measurement shaft and the 2nd length measurement shaft which cross at right angles to mutual focusing on projection of said projection optics, and the 3rd length measurement shaft and the 4th length measurement shaft which cross at right angles to mutual focusing on detection of said alignment system,
Said control means is an aligner according to claim 1 characterized by resetting the length measurement shaft of said interferometer systems in case the location of the stage of said one side and another side is replaced.
[Claim 4]
It is the aligner which exposes a pattern on an induction substrate through projection optics,
An induction substrate is held and it is the movable 1st substrate stage about the inside of a two-dimensional flat surface.;
Holding an induction substrate, said 1st substrate stage is the independently movable 2nd substrate stage about the inside of the same flat surface as said 1st substrate stage.;
Alignment system for detecting the mark on the induction substrate which was formed apart from said projection optics and held on said substrate stage or on this stage;
Interferometer systems for measuring the two-dimensional location of said 1st substrate stage and the 2nd substrate stage, respectively;
The 1st predetermined location in the stage successive range at the time of the exposure to which exposure is performed through said projection optics in each of said two substrate stages to the induction substrate held on the stage, The 2nd predetermined location in the stage successive range at the time of the alignment to which mark detection on the induction substrate held by said alignment system on a stage or on this stage is carried out, Migration means to which delivery of an induction substrate is carried out between a substrate stage and an external substrate conveyance device, and it is made to move among 3 points of the 3rd location of ****;
The location of one stage of said 1st substrate stage and the 2nd substrate stages is managed by said interferometer systems. While a pattern is exposed through said projection optics by the induction substrate held on one [this] stage Said 1st substrate stage And the alignment actuation which measures the physical relationship of exchange of an induction substrate and the alignment mark on said induction substrate, and the reference point on the stage of said another side based on the detection result of said alignment system and the measurement value of said interferometer systems on the stage of another side of the 2nd substrate stages While controlling said two substrate stages and said migration means to be carried out one by one The aligner which has the control means which controls said two stages and said migration means so that the

actuation performed on said two stages may interchange, after both actuation of said two stages is completed.
[Claim 5]
It has further the mask with which the pattern was formed,
The aligner according to claim 4 with which the image of the pattern formed in said mask is characterized by carrying out projection exposure at the induction substrate on said 1st substrate stage and the 2nd substrate stage through projection optics.
[Claim 6]
Said interferometer systems are equipped with the 1st length measurement shaft and the 2nd length measurement shaft which cross at right angles to mutual focusing on projection of said projection optics, and the 3rd length measurement shaft and the 4th length measurement shaft which cross at right angles to mutual focusing on detection of said alignment system,
Said control means is an aligner according to claim 5 characterized by resetting the 1st and 2nd length measurement shaft of said interferometer systems in the case of migration in said 1st location, and resetting the 3rd and 4th length measurement shaft of said interferometer systems about each of said two stages in the case of migration in said 2nd location.
[Claim 7]
The aligner according to claim 6 characterized by having further a mark location detection means to detect the relative-position relation between the projection core of the pattern image of said mask, and the reference point on said stage through said mask and said projection optics.
[Claim 8]
It has the substrate attachment component which said each substrate stage is carried free [attachment and detachment] on a stage body and this body, and holds a substrate, and the reflector for interferometers is established in the side face of this substrate attachment component, and a reference mark is formed in the top face of said substrate attachment component as said reference point,
An aligner given in claim 2 to which said migration means is characterized by moving said substrate attachment component between said every place points instead of said substrate stage thru/or any 1 term of 7..
[Claim 9]
Said migration means is an aligner given in claim 2 characterized by being constituted by the robot arm thru/or any 1 term of 8.
[Claim 10]
An aligner given in claim 2 characterized by attaching in said projection optics and said alignment system the fixed mirror which serves as criteria of length measurement by the interferometer, respectively thru/or any 1 term of 9.
[Claim 11]
It is an aligner given in claim 2 characterized by holding the induction substrate other than said 1st substrate stage and the 2nd substrate stage, and these stages having further at least one another, independently movable substrate stage for the inside of said two same flat surfaces as a substrate stage thru/or any 1 term of 10.
[Claim 12]
It is the aligner which exposes an induction substrate,
The 1st substrate attachment component which has a reflector for interferometers;
The 2nd substrate attachment component which has a reflector for interferometers;
The 1st stage section possible [in a substrate attachment component] desorption and movable in the direction of two dimension where one substrate attachment component is held;
Where desorption is possible in a substrate attachment component and the substrate attachment component of another side is held, said 1st stage section is the 2nd stage section movable in the direction of two dimension independently.;
The 1st interferometer systems which said 1st stage section was equipped with while, and measure the location of a substrate attachment component using the reflector of the substrate attachment component with which said 1st stage section was equipped;
It has the 2nd interferometer systems and; which measure the location of the substrate attachment component with which said 2nd stage section was equipped using the reflector of the substrate attachment component of another side with which said 2nd stage section was equipped,
Where said 1st stage section is equipped with one [said] substrate attachment component and said 2nd

stage section is equipped with the substrate attachment component of said another side in parallel to exposure of the induction substrate held at one [said] substrate attachment component, alignment measurement actuation of the induction substrate held at the substrate attachment component of said another side is performed,
Said exposure in the condition of having equipped said 1st stage section with one [said] substrate attachment component, And after said alignment measurement actuation in the condition of having equipped said 2nd stage section with the substrate attachment component of said another side is completed, said 1st stage section is equipped with the substrate attachment component of said another side with which said 2nd stage section was equipped. The aligner with which exposure of the induction substrate held at the substrate attachment component of said another side is performed.
[Claim 13]
The aligner according to claim 12 with which said 2nd stage section is equipped with one [with which said 1st stage section was equipped / said] substrate attachment component while said 1st stage section is equipped with the substrate attachment component of said another side with which said 2nd stage section was equipped.
[Claim 14]
The aligner according to claim 12 or 13 exchanged between said 1st stage sections and said 2nd stage sections in said 1st substrate attachment component and said 2nd substrate attachment component.
[Claim 15]
An aligner given in any 1 term of claims 12-14 further equipped with the 1st transport device which moves the substrate attachment component of said another side with which said 2nd stage section was equipped to said 1st stage section.
[Claim 16]
The aligner according to claim 15 further equipped with the 2nd transport device which moves one [with which said 1st stage section was equipped / said] substrate attachment component to said 2nd stage section.
[Claim 17]
said 1st stage section -- any of said 1st and 2nd substrate attachment component -- although -- the 1st stopper and; which hold said 1st stage section in a predetermined location when not equipped
said 2nd stage section -- any of said 1st and 2nd substrate attachment component -- although -- an aligner given in any 1 term of claims 12-16 further equipped with the 2nd stopper which holds said 2nd stage section in a predetermined location, and; when not equipped.
[Claim 18]
It has further the projection optics which projects the pattern image of a mask on an induction substrate,
The 1st physical relationship of the shot field on the induction substrate held at the substrate attachment component of said another side and the criteria of the substrate attachment component of said another side is determined by alignment measurement actuation in the condition of having equipped said 2nd stage section with the substrate attachment component of said another side,
After equipping said 1st stage section with the substrate attachment component of said another side, the 2nd physical relationship of the criteria of the substrate attachment component of said another side and the mark of said mask is measured through said projection optics,
An aligner given in any 1 term of claims 12-17 by which alignment of the shot field and said mask on the induction substrate held at the substrate attachment component of said another side with which said 1st stage section was equipped based on said 1st physical relationship and said 2nd physical relationship is carried out one by one, and sequential exposure of the shot field on the induction substrate held at the substrate attachment component of said another side is carried out.
[Claim 19]
The 1st alignment system which detects the alignment mark on said substrate in order to search for said 1st physical relationship;
The aligner according to claim 18 further equipped with the 2nd alignment system which measures said 2nd physical relationship, and;.
[Claim 20]
Said alignment measurement actuation is performed measuring the location of the reflector of the substrate attachment component of said another side with which said 2nd stage section was equipped using said 2nd interferometer systems,
Reset of the length measurement shaft of said 1st interferometer systems which has hit the reflector of the substrate attachment component of said another side with which said 1st stage section was equipped is

performed after termination of said alignment measurement actuation,
An aligner given in any 1 term of claims 12-19 by which sequential exposure of the shot field on the induction substrate held at the substrate attachment component of said another side while measuring the location of the reflector of the substrate attachment component of said another side with which said 1st stage section was equipped after said reset using said 1st interferometer systems is carried out.
[Claim 21]
It is the aligner which exposes the image of the pattern formed in the mask on an induction substrate through projection optics,
Base;
It has a reflector for interferometers, an induction substrate is held on said base, and it is the movable 1st substrate stage about the inside of a two-dimensional flat surface.;
It has a reflector for interferometers, an induction substrate is held, and it is the movable 2nd substrate stage about the inside of a two-dimensional flat surface independently of said 1st substrate stage on said base.;
The 1st alignment system which detects the alignment mark on an induction substrate;
The 2nd alignment system which measures the physical relationship of the criteria prepared in said substrate stage, and the mark of said mask through said projection optics;
The 1st interferometer systems from which have a length measurement shaft for measuring the location of the substrate stage holding the induction substrate with which alignment measurement actuation using said 1st alignment system is performed, and this length measurement shaft separates from the reflector of said substrate stage after said alignment measurement actuation termination;
It has a length measurement shaft for measuring the location of the substrate stage holding the induction substrate with which exposure actuation using said projection optics is performed, and has the 2nd interferometer systems and; from which this length measurement shaft separates from the reflector of said substrate stage after said exposure actuation termination,
The 1st physical relationship of the shot field of the induction substrate held on the substrate stage of said another side and the criteria prepared in the substrate stage of said another side is determined by detecting the alignment mark on the induction substrate held on the substrate stage of another side by said 1st alignment system in parallel to exposure actuation of the induction substrate held on one substrate stage of said two substrate stages,
While the substrate stage of said another side is moved to the predetermined location by the side of the image surface of said projection optics after exposure termination of the induction substrate held on one [said] substrate stage, the 2nd physical relationship of the criteria prepared in the substrate stage of said another side and the mark of said mask is measured using said 2nd alignment system,
The aligner with which sequential exposure of the shot field on the induction substrate currently held on the substrate stage of said another side is carried out based on the location of the substrate stage of said another side measured by said 1st and 2nd physical relationship and said 2nd interferometer systems.
[Claim 22]
It has further a conveyance means to perform exchange actuation of an induction substrate between said substrate stages,
The aligner according to claim 21 with which the alignment mark on the unexposed induction substrate with which the induction substrate after the exposure held on one [said] substrate stage was held on one [said] substrate stage in parallel to exposure of the induction substrate held on the substrate stage of said another side while being exchanged for the unexposed induction substrate using said conveyance means is detected using said 1st alignment system.
[Claim 23]
The aligner according to claim 21 or 22 which includes further a measurement means to measure the location of said substrate stage when both the length measurement shaft of said 1st interferometer systems and the length measurement shaft of said 2nd interferometer systems have run out.
[Claim 24]
Said measurement means is an aligner containing an optical encoder according to claim 23.
[Claim 25]
The device manufacture approach including the lithography process which exposes an induction substrate using the aligner indicated by any 1 term of claims 12-24.
[Procedure amendment 2]
[Document to be Amended] Specification
[Item(s) to be Amended] 0039

[Method of Amendment] Modification
[The contents of amendment]
[0039]
In each above-mentioned invention, although only two, the 1st substrate stage and the 2nd substrate stage, were prepared, like invention according to claim 11, the induction substrate other than said 1st substrate stage (WS1) and the 2nd substrate stage (WS2) may be held, and these stages may prepare further at least one another, independently movable substrate stage for the inside of said two same flat surfaces as a substrate stage.
Moreover, according to another mode of this invention, it is the aligner which exposes an induction substrate (W). Desorption is possible in the 1st substrate attachment component (WS1b) which has a reflector for interferometers, the 2nd substrate attachment component (WS2b) which has a reflector for; interferometers, and; substrate attachment component. Where desorption is possible in the 1st stage section (WS2a) movable in the direction of two dimension, and; substrate attachment component where one substrate attachment component is held, and the substrate attachment component of another side is held The reflector of the substrate attachment component with which the 2nd stage section (WS1a) movable in the direction of two dimension and the; 1st stage section (WS2a) were independently equipped with the 1st stage section (WS2a) is used. The 1st stage section (WS2a) was equipped and the reflector of the substrate attachment component of another side with which the 1st interferometer systems (26Xe, 26Ye) which measure the location of a substrate attachment component and the; 2nd stage section (WS1a) were equipped is used. Where it had the 2nd interferometer systems (26Xa, 26Ya) and; which measure the location of the substrate attachment component with which the 2nd stage section (WS1a) was equipped and the 1st stage section (WS2a) is equipped with one substrate attachment component (for example, WS2b) In parallel to exposure of the induction substrate held at one substrate attachment component (WS2b), where the 2nd stage section (WS1a) is equipped with the substrate attachment component (WS1b) of another side Alignment measurement actuation of the induction substrate held at the substrate attachment component (WS1b) of another side is performed. Exposure in the condition of having equipped the 1st stage section (WS2a) with one substrate attachment component (WS2b), And after alignment measurement actuation in the condition of having equipped the 2nd stage section (WS1a) with the substrate attachment component (WS1b) of another side is completed The 1st stage section (WS2a) is equipped with the substrate attachment component (WS1b) of another side with which the 2nd stage section (WS1a) was equipped, and the aligner with which exposure of the induction substrate held at the substrate attachment component (WS1b) of another side is performed is offered.
According to this, a throughput can be raised by carrying out parallel processing of exposure actuation of one stage section, and the alignment measurement actuation of the stage section of another side.
If it depends like, it will be the aligner which exposes the image of the pattern formed in the mask (R) on an induction substrate (W) through projection optics (PL). moreover, another voice of this invention -- Have a reflector for the base (12) and; interferometers, and hold an induction substrate on the base (12), and have the movable 1st substrate stage (WS1) and a reflector for; interferometers for the inside of a two-dimensional flat surface, and an induction substrate is held. The base (12) In a top The 1st substrate stage Independently of (WS1), the inside of a two-dimensional flat surface Projection optics (PL) is minded for the physical relationship of the movable 2nd substrate stage (WS2), the 1st alignment system (WA) which detects the alignment mark on; induction substrate and the criteria (FM1, FM2) prepared in; substrate stage, and the mark of a mask. It has a length measurement shaft (Xa, Ya) for measuring the location of the substrate stage (WS1 or WS2) holding the induction substrate with which alignment measurement actuation using the 2nd alignment system (56A, 56B) and the; 1st alignment system (WA) to measure is performed. This length measurement shaft (Xa, Ya) The location of the substrate stage (WS1 or WS2) holding the induction substrate with which exposure actuation using the 1st interferometer systems (26Xa, 26Ya) and; projection optics (PL) from which it separates from the reflector of a substrate stage after alignment measurement actuation termination is performed It has a length measurement shaft (Xe, Ye) for measuring. This length measurement shaft (Xe, Ye) It has the 2nd interferometer systems (26Xa, 26Ya) and; from which it separates from the reflector of a substrate stage after exposure actuation termination. Are concurrent with exposure actuation of the induction substrate held on one substrate stage of the two substrate stages (for example, WS2). By detecting the alignment mark on the induction substrate held on the substrate stage (WS1) of another side by the 1st alignment system (WA) The 1st physical relationship of the shot field of the induction substrate held on the substrate stage (WS1) of another side and the criteria (FM1) prepared in the substrate stage (WS1) of another side is determined. While the substrate stage (WS1) of

another side is moved to the predetermined location by the side of the image surface of projection optics (PL) after exposure termination of the induction substrate held on one substrate stage (WS2) The 2nd physical relationship of the criteria (FM1) and the mark of a mask (R) which were prepared in the substrate stage (WS1) of another side is measured using the 2nd alignment system (56A, 56B). Based on the 1st and 2nd physical relationship and the location of the substrate stage (WS1) of another side measured by the 2nd interferometer systems (26Xa, 26Ya), the aligner with which sequential exposure of the shot field on the induction substrate currently held on the substrate stage (WS1) of another side is carried out is offered. According to this, a throughput can be raised by carrying out parallel processing of exposure actuation of one substrate stage, and the alignment measurement actuation of the substrate stage of another side.

[Translation done.]

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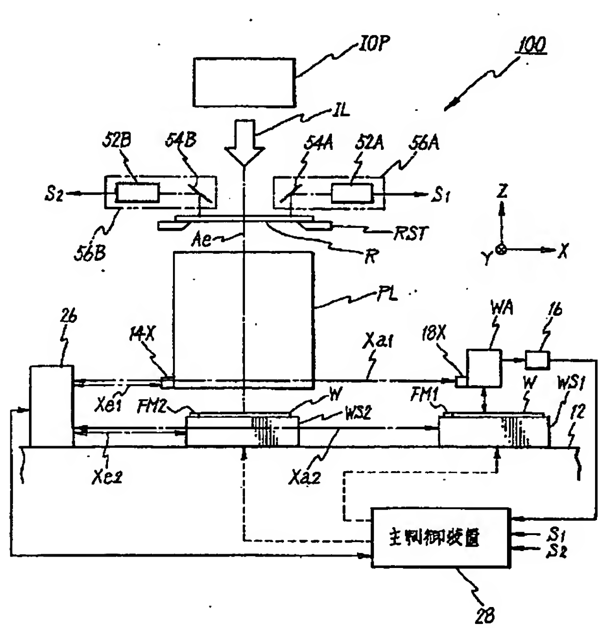
(54)【発明の名称】　露光方法及び露光装置

(57)【要約】

【課題】　スループットを向上させることができるとともに、ベースライン量に無関係に基板ステージの大きさを定めることができる露光方法を提供する。

【解決手段】　例えば、ステージＷＳ２に保持された基板Ｗ上に投影光学系ＰＬを介してマスクＲのパターン像の露光が行われる間に、①ステージＷＳ１に保持された基板Ｗ上の位置合わせマークと該ステージＷＳ１上の基準点との位置関係が計測される。そして、ステージＷＳ２に保持された基板Ｗの露光終了後に、ステージＷＳ１上の基準点を投影光学系ＰＬの投影領域内に位置決めした状態で、②その投影領域内の所定の基準点に対するステージＷＳ１上の基準点の位置ずれ及び③その位置ずれ検出時のステージＷＳ１の座標位置が検出される。その後に、①、②、③の検出結果に基づいてステージＷＳ１の移動を制御し、ステージＷＳ１に保持された基板ＷとマスクＲのパターン像との位置合わせが行われる。



【特許請求の範囲】

【請求項１】　マスクに形成されたパターンの像を投影光学系を介して感応基板上に露光する露光方法であって、

感応基板を保持して各々同一の平面内を独立に移動可能な２つの基板ステージを用意し、

前記２つの基板ステージの内の一方の基板ステージに保持された感応基板上に前記投影光学系を介して前記マスクのパターン像を露光し、

前記一方の基板ステージに保持された感応基板の露光中に、前記２つの基板ステージの内の他方の基板ステージに保持された感応基板上の位置合わせマークと前記他方のステージ上の基準点との位置関係を計測し、

前記一方の基板ステージに保持された感応基板の露光終了後に、前記他方の基板ステージ上の基準点を前記投影光学系の投影領域内に位置決めした状態で、その投影領域内の所定の基準点に対する前記他方の基板ステージ上の基準点の位置ずれ及び前記他方の基板ステージの座標位置を検出し、

前記検出された位置関係、前記検出された位置ずれ及び前記検出された座標位置に基づいて前記他方の基板ステージの移動を制御し、前記他方のステージに保持された感応基板と前記マスクのパターン像との位置合わせを行うことを特徴とする露光方法。

【請求項２】　投影光学系を介して感応基板上にパターンを露光する露光装置であって、

感応基板を保持して２次元平面内を移動可能な第１基板ステージと；感応基板を保持して前記第１基板ステージと同一平面内を前記第１基板ステージとは独立に移動可能な第２基板ステージと；前記投影光学系とは別に設けられ、前記基板ステージ上又は該ステージに保持された感応基板上のマークを検出するためのアライメント系と；前記第１基板ステージ及び第２基板ステージの２次元位置をそれぞれ計測するための干渉計システムと；前記２つの基板ステージのそれぞれを、該ステージ上に保持された感応基板に対して前記投影光学系を介して露光が行われる露光時のステージ移動範囲内の所定の第１位置と、前記アライメント系によりステージ上又は該ステージに保持された感応基板上のマーク検出が行われるアライメント時のステージ移動範囲内の所定の第２位置との間で移動させる移動手段と；前記第１基板ステージ及び第２基板ステージの内の一方のステージに保持された感応基板が露光される間に、前記第１基板ステージ及び第２基板ステージの内の他方のステージ上で前記アライメント系によるマーク検出動作が行われるように、前記干渉計システムの計測値をモニタしつつ、前記２つのステージの動作を制御した後に、前記移動手段を制御して前記一方の基板ステージと他方の基板ステージの位置を入れ替える制御手段とを有する露光装置。

【請求項３】　前記干渉計システムは、前記投影光学系の投影中心で相互に垂直に交差する第１測長軸及び第２測長軸と、前記アライメント系の検出中心で相互に垂直に交差する第３測長軸及び第４測長軸とを備え、

前記制御手段は、前記一方と他方のステージの位置を入れ替える際に、前記干渉計システムの測長軸をリセットすることを特徴とする請求項１に記載の露光装置。

【請求項４】　投影光学系を介して感応基板上にパターンを露光する露光装置であって、

感応基板を保持して２次元平面内を移動可能な第１基板ステージと；感応基板を保持して前記第１基板ステージと同一平面内を前記第１基板ステージとは独立に移動可能な第２基板ステージと；前記投影光学系とは別に設けられ、前記基板ステージ上又は該ステージに保持された感応基板上のマークを検出するためのアライメント系と；前記第１基板ステージ及び第２基板ステージの２次元位置をそれぞれ計測するための干渉計システムと；前記２つの基板ステージのそれぞれを、ステージ上に保持された感応基板に対して前記投影光学系を介して露光が行われる露光時のステージ移動範囲内の所定の第１位置と、前記アライメント系によりステージ上又は該ステージに保持された感応基板上のマーク検出が行われるアライメント時のステージ移動範囲内の所定の第２位置と、基板ステージと外部の基板搬送機構との間で感応基板の受け渡しが行われれる第３位置の３地点間で移動させる移動手段と；前記第１基板ステージ及び第２基板ステージの内の一方のステージの位置が前記干渉計システムにより管理され、該一方のステージに保持された感応基板に前記投影光学系を介してパターンが露光される間に、前記第１基板ステージ及び第２基板ステージの内の他方のステージ上で感応基板の交換及び前記感応基板上のアライメントマークと前記他方のステージ上の基準点との位置関係を前記アライメント系の検出結果と前記干渉計システムの計測値とに基づいて計測するアライメント動作が順次行われるように前記２つの基板ステージ及び前記移動手段を制御するとともに、前記２つのステージの動作がともに終了した後に、前記２つのステージ上で行われる動作が入れ替わるように、前記２つのステージと前記移動手段とを制御する制御手段とを有する露光装置。

【請求項５】　パターンが形成されたマスクを更に有し、

前記マスクに形成されたパターンの像が投影光学系を介して前記第１基板ステージ及び第２基板ステージ上の感応基板に投影露光されることを特徴とする請求項４に記載の露光装置。

【請求項６】　前記干渉計システムは、前記投影光学系の投影中心で相互に垂直に交差する第１測長軸及び第２測長軸と、前記アライメント系の検出中心で相互に垂直に交差する第３測長軸及び第４測長軸とを備え、

前記制御手段は、前記２つのステージのそれぞれについ

て、前記第１位置への移動の際に前記干渉計システムの第１及び第２測長軸をリセットし、前記第２位置へ移動の際に前記干渉計システムの第３及び第４測長軸をリセットすることを特徴とする請求項５に記載の露光装置。

【請求項７】　前記マスクのパターン像の投影中心と前記ステージ上の基準点との相対位置関係を前記マスクと前記投影光学系を介して検出するマーク位置検出手段を更に有することを特徴とする請求項６に記載の露光装置。

【請求項８】　前記各基板ステージが、ステージ本体と、この本体上に着脱自在に搭載され基板を保持する基板保持部材とを有し、該基板保持部材の側面には干渉計用反射面が設けられ且つ前記基板保持部材の上面には前記基準点として基準マークが形成され、

前記移動手段が、前記基板ステージの代わりに前記基板保持部材を前記各地点間で移動させることを特徴とする請求項２ないし７のいずれか一項に記載の露光装置。

【請求項９】　前記移動手段は、ロボットアームによって構成されていることを特徴とする請求項２ないし８のいずれか一項に記載の露光装置。

【請求項１０】　前記投影光学系、前記アライメント系には、それぞれ干渉計による測長の基準となる固定鏡が取り付けられていることを特徴とする請求項２ないし９のいずれか一項に記載の露光装置。

【請求項１１】　前記第１基板ステージ及び第２基板ステージの他に、感応基板を保持して前記２つの基板ステージと同一平面内をこれらのステージとは独立に移動可能な少なくとも１つの別の基板ステージを更に有することを特徴とする請求項２ないし１０のいずれか一項に記載の露光装置。

【発明の詳細な説明】

【０００１】

【発明の属する技術分野】本発明は、露光方法及び露光装置に係り、更に詳しくは、半導体素子や液晶表示素子等をリソグラフィ工程で製造する際に用いられるマスクパターンを投影光学系を介して感応基板上に露光する露光方法及び露光装置、あるいは半導体素子、半導体素子製造用マスク等の製造のため、レーザ光、電子線その他の荷電粒子線等で感応基板上にパターンを直接描画する描画装置等の露光装置に関する。本発明は、感応基板を保持する基板ステージを複数有する点に特徴を有するものである。

【０００２】

【従来の技術】従来より、半導体素子又は液晶表示素子等をフォトリソグラフィ工程で製造する場合に、種々の露光装置が使用されているが、現在では、フォトマスク又はレチクル（以下、「レチクル」と総称する）のパターン像を、投影光学系を介して表面にフォトレジスト等の感光材が塗布されたウエハ又はガラスプレート等の基板（以下、適宜「感応基板」又は「ウエハ」と称する）上に転写する投影露光装置が一般的に使用されている。近年では、この投影露光装置として、感応基板を２次元的に移動自在な基板ステージ上に載置し、この基板ステージにより感応基板を歩進（ステッピング）させて、レチクルのパターン像を感応基板上の各ショット領域に順次露光する動作を繰り返す、所謂ステップ・アンド・リピート方式の縮小投影露光装置（いわゆるステッパー）が主流となっている。

【０００３】最近になって、このステッパー等の静止型露光装置に改良を加えた、ステップ・アンド・スキャン方式の投影露光装置（例えば特開平７－１７６４６８号公報に記載された様な走査型露光装置）も比較的多く用いられるようになってきた。このステップ・アンド・スキャン方式の投影露光装置は、①ステッパーに比べると大フィールドをより小さな光学系で露光できるため、投影光学系の製造が容易であるとともに、大フィールド露光によるショット数の減少により高スループットが期待出来る、②投影光学系に対してレチクル及びウエハを相対走査することで平均化効果があり、ディストーションや焦点深度の向上が期待出来る等のメリットがある。

【０００４】この種の投影露光装置においては、露光に先立ってレチクルとウエハとの位置合わせ（アライメント）を高精度に行う必要がある。このアライメントを行うために、ウエハ上には以前のフォトリソグラフィ工程で形成（露光転写）された位置検出用マーク（アライメントマーク）が設けられており、このアライメントマークの位置を検出することで、ウエハ（又はウエハ上の回路パターン）の正確な位置を検出することができる。

【０００５】アライメントマークを検出するアライメント顕微鏡としては、大別して投影レンズを介してマーク検出を行なうオンアクシス方式と、投影レンズを介さずマーク検出を行なうオフアクシス方式のものとがあるが、今後の主流になるであろうエキシマレーザ光源を用いる投影露光装置では、オフアクシス方式のアライメント顕微鏡が最適である。これは、投影レンズは露光光に対して色収差の補正がなされているので、オンアクシスの場合、アライメント光が集光できないか、集光できたとしても色収差による誤差が非常に大きなものとなるのに対し、オフアクシス方式のアライメント顕微鏡は、投影レンズとは別に設けられていることから、このような色収差を考慮することなく、自由な光学設計が可能であること、及び種々のアライメント系が使用できるからである。例えば、位相差顕微鏡や微分干渉顕微鏡等も使用できる。

【０００６】ところで、この種の投影露光装置における処理の流れは、大要次のようになっている。

【０００７】①　まず、ウエハローダを使ってウエハをウエハテーブル上にロードするウエハロード工程が行なわれ、次いでウエハ外形を基準とする等によりいわゆるサーチアライメントが行なわれる。

【０００８】②　次に、ウエハ上の各ショット領域の位置を正確に求めるファインアライメント工程が行なわれる。このファインアライメント工程は、一般にＥＧＡ（エンハンスト・グローバル・アライメント）方式が用いられ、この方式は、ウエハ内の複数のサンプルショットを選択しておき、当該サンプルショットに付設されたアライメントマーク（ウエハマーク）の位置を順次計測し、この計測結果とショット配列の設計値とに基づいて、いわゆる最小自乗法等による統計演算を行なって、ウエハ上の全ショット配列データを求めるものであり（特開昭６１－４４４２９号公報等参照）、高スループットで各ショット領域の座標位置を比較的高精度に求めることができる。

【０００９】③　次に、上述したＥＧＡ方式等により求めた各ショット領域の座標位置と予め計測したベースライン量とに基づいて露光位置にウエハ上の各ショット領域を順次位置決めしつつ、投影光学系を介してレチクルのパターン像をウエハ上に転写する露光工程が行なわれる。

【００１０】④　次に、露光処理されたウエハテーブル上のウエハをウエハアンローダを使ってアンロードさせるウエハアンロード工程が行なわれる。このウエハアンロード工程は、上記①のウエハロード工程と同時に行なわれる。すなわち、①と④とによってウエハ交換工程が構成される。

【００１１】このように、従来の投影露光装置では、ウエハ交換（サーチアライメントを含む）→ファインアライメント→露光→ウエハ交換……のように、大きく３つの動作が１つのウエハステージを用いて繰り返し行なわれている。

【００１２】

【発明が解決しようとする課題】上述した投影露光装置は、主として半導体素子等の量産機として使用されるものであることから、一定時間内にどれだけの枚数のウエハを露光処理できるかという処理能力、すなわちスループットを向上させることが必然的に要請される。

【００１３】これに関し、現状の投影露光装置では、上述した３つの動作がシーケンシャルに行われることから、スループット向上のためには、各動作に要する時間を短縮する必要があるが、ウエハ交換（サーチアライメントを含む）は、ウエハ１枚に対して一動作が行なわれるだけであるから改善の効果は比較的小さい。また、ファインアライメントに要する時間は、上述したＥＧＡ方式を用いる際にショットのサンプリング数を少なくしたり、ショット単体の計測時間を短縮することにより、短縮することができるが、これらのことは、却ってアライメント精度を劣化させることになるため、安易にファインアライメントに要する時間を短縮することはできない。

【００１４】従って、結論的には、露光に要する時間を短縮することがスループット向上のためには、最も効果的であるということになるが、この露光動作には、ステッパーの場合、純粋なウエハ露光時間とショット間のステッピング時間とを含んでおり、ウエハ露光時間の短縮には光源の光量が大きいことが必須となるが、この種の投影露光装置では上記スループット面の他に、重要な条件として、①解像度、②焦点深度（ＤＯＦ：Depth of Forcus ）、③線幅制御精度等があり、解像度Ｒは、露光波長をλとし、投影レンズの開口数をＮ．Ａ．（Numerical Aperture ）とすると、λ／Ｎ．Ａ．に比例し、焦点深度ＤＯＦはλ／（Ｎ．Ａ．）^{2} に比例する。このため、光源としては波長の短いものであることも必要であり、従来用いられていた超高圧水銀ランプの輝線（ｇ線、ｉ線）等に比べパワーが大きく、短波長であるという両方の要件を満たすものとして先に述べたエキシマレーザが今後の主流になると言われ、これより波長が短く、光量が大きく、露光装置の光源として適切な光源は、現段階では考えられていない。従って、光源としてエキシマレーザを用いる場合以上のスループットの向上はあまり期待できず、光源の工夫によるスループットの向上にも限界がある。

【００１５】一方、ショット間のステッピング時間の短縮のためには、ウエハを保持するステージの最高速度、最高加速度を向上させる必要があるが、最高速度、最高加速度の向上はステージの位置決め精度の劣化を招きやすいという不都合があった。この他、ステップ・アンド・スキャン方式のような走査型投影露光装置の場合は、レチクルとウエハの相対走査速度を上げることによりウエハの露光時間の短縮が可能であるが、相対走査速度の向上は同期精度の劣化を招き易いので、安易に走査速度を上げることができない。従って、ステージの制御性を向上させることが必要となる。

【００１６】しかしながら、特に今後主流になるであろうエキシマレーザ光源を用いる投影露光装置のようにオフアクシスアライメント顕微鏡を用いる装置では、ステージの制御性を向上させることは、容易ではない。すなわち、この種の投影露光装置では、投影光学系を介してのマスクパターンの露光時と、アライメント時との両方でウエハステージの位置をアッベ誤差なく正確に管理し、高精度な重ね合わせを実現するためには、レーザ干渉計の測長軸が投影光学系の投影中心とアライメント顕微鏡の検出中心とをそれぞれ通るように設定する必要があり、しかも露光時のステージの移動範囲内とアライメント時のステージの移動範囲内との両方で前記投影光学系の投影中心を通る測長軸とアライメント顕微鏡の検出中心を通る測長軸とが共に切れないようにする必要があるため、ステージが必然的に大型化するからである。

【００１７】以上より、前述した３つの動作の個々の動作に要する時間を短縮するという手法では、何らのデメリットなくスループットを向上させることは困難であ

り、これとは別の手法によりスループットを向上させる新技術の出現が待望されていた。

【００１８】本発明は、かかる事情の下になされたもので、請求項１に記載の発明の目的は、スループットを向上させることができるとともに、ベースライン量に無関係に基板ステージの大きさを定めることができる露光方法を提供することにある。

【００１９】また、請求項２ないし１１に記載の発明の目的は、スループットを向上させることができる露光装置を提供することにある。

【００２０】

【課題を解決するための手段】前述した３つの動作、すなわちウエハ交換（サーチアライメントを含む）、ファインアライメント、及び露光動作の内の複数動作同士を部分的にでも同時並行的に処理できれば、これらの動作をシーケンシャルに行なう場合に比べて、スループットを向上させることができると考えられる。本発明は、かかる観点に着目してなされたもので、以下のような方法及び構成を採用する。すなわち、請求項１に記載の発明は、マスク（Ｒ）に形成されたパターンの像を投影光学系（ＰＬ）を介して感応基板（Ｗ）上に露光する露光方法であって、感応基板（Ｗ）を保持して各々同一の平面内を独立に移動可能な２つの基板ステージ（ＷＳ１、ＷＳ２）を用意し；前記２つの基板ステージ（ＷＳ１、ＷＳ２）の内の一方の基板ステージ（ＷＳ１又はＷＳ２）に保持された感応基板（Ｗ）上に前記投影光学系（ＰＬ）を介して前記マスク（Ｒ）のパターン像を露光し；前記一方の基板ステージ（ＷＳ１又はＷＳ２）に保持された感応基板（Ｗ）の露光中に、前記２つの基板ステージの内の他方の基板ステージ（ＷＳ２又はＷＳ１）に保持された感応基板（Ｗ）上の位置合わせマークと前記他方のステージ（ＷＳ２又はＷＳ１）上の基準点との位置関係を計測し；前記一方の基板ステージに保持された感応基板の露光終了後に、前記他方の基板ステージ上の基準点を前記投影光学系（ＰＬ）の投影領域内に位置決めした状態で、その投影領域内の所定の基準点に対する前記他方の基板ステージ上の基準点の位置ずれ及び前記他方の基板ステージの座標位置を検出し；前記検出された位置関係、前記検出された位置ずれ及び前記検出された座標位置に基づいて前記他方の基板ステージの移動を制御し、前記他方のステージに保持された感応基板と前記マスクのパターン像との位置合わせを行うことを特徴とする。

【００２１】これによれば、２つの基板ステージ（ＷＳ１、ＷＳ２）の内の一方の基板ステージ（ＷＳ１又はＷＳ２）に保持された感応基板（Ｗ）上に前記投影光学系（ＰＬ）を介して前記マスク（Ｒ）のパターン像の露光が行われる間に、①２つの基板ステージの内の他方の基板ステージ（ＷＳ２又はＷＳ１）に保持された感応基板（Ｗ）上の位置合わせマークと他方のステージ（ＷＳ２又はＷＳ１）上の基準点との位置関係が計測される。このように、一方の基板ステージ側の露光動作と他方の基板ステージ側のアライメント動作（他方の基板ステージに保持された感応基板上の位置合わせマークと他方のステージ上の基準点との位置関係の計測）とを並行して行なうことができるので、これらの動作をシーケンシャルに行なっていた従来技術に比べてスループットの向上を図ることが可能である。

【００２２】そして、上記の一方の基板ステージに保持された感応基板の露光終了後に、前記他方の基板ステージ（ＷＳ２又はＷＳ１）上の基準点を投影光学系（ＰＬ）の投影領域内に位置決めした状態で、②その投影領域内の所定の基準点に対する他方の基板ステージ上の基準点の位置ずれ及び③その位置ずれ検出時の他方の基板ステージの座標位置が検出される。その後に、①検出された位置関係、②検出された位置ずれ及び③検出された座標位置に基づいて他方の基板ステージ（ＷＳ２又はＷＳ１）の移動を制御し、他方のステージに保持された感応基板と前記マスクのパターン像との位置合わせが行われる。

【００２３】このため、①の他方の基板ステージ上の所定の基準点と感応基板上の位置合わせマークとの位置関係検出時に当該基板ステージの位置を管理する干渉計（あるいは座標系）と、②、③の位置ずれ検出及び基板ステージの座標位置の検出の際のステージの位置を管理する干渉計（あるいは座標系）とが同一でも異なっていても何らの不都合なく、マスクのパターン像と前記他方の基板ステージに搭載された感応基板との位置合わせを高精度に行なうことができる。

【００２４】従って、例えば位置合わせマークを検出するマーク検出系としてオフアクシスのアライメント系を用いる場合、投影光学系の投影領域内の所定の基準点（マスクのパターン像の投影中心）とアライメント系の検出中心との位置関係、すなわちベースライン量の計測が不要となり、結果的に投影光学系とアライメント系とが大きく離れていても何らの不都合がないので、ベースライン量に無関係に基板ステージの大きさを設定することができ、基板ステージを小型・軽量化しても何らの不都合なく、感応基板の全面に対してマーク位置計測、投影光学系を介したパターンの露光を行なうことができる。この場合、ベースライン量の変動の影響を受けることもない。

【００２５】請求項２に記載の発明は、投影光学系（ＰＬ）を介して感応基板（Ｗ）上にパターンを露光する露光装置であって、感応基板（Ｗ）を保持して２次元平面内を移動可能な第１基板ステージ（ＷＳ１）と；感応基板（Ｗ）を保持して前記第１基板ステージ（ＷＳ１）と同一平面内を前記第１基板ステージ（ＷＳ１）とは独立に移動可能な第２基板ステージ（ＷＳ２）と；前記投影光学系（ＰＬ）とは別に設けられ、前記基板ステージ

（ＷＳ１、ＷＳ２）上又は該ステージに保持された感応基板（Ｗ）上のマークを検出するためのアライメント系（ＷＡ）と；前記第１基板ステージ及び第２基板ステージの２次元位置をそれぞれ計測するための干渉計システム（２６）と；前記２つの基板ステージのそれぞれを、該ステージ上に保持された感応基板に対して前記投影光学系を介して露光が行われる露光時のステージ移動範囲内の所定の第１位置と、前記アライメント系によりステージ上又は該ステージに保持された感応基板上のマーク検出が行われるアライメント時のステージ移動範囲内の所定の第２位置との間で移動させる移動手段（２０、２２）と；第１基板ステージ及び第２基板ステージの内の一方のステージに保持された感応基板が露光される間に、前記第１基板ステージ及び第２基板ステージの内の他方のステージ上で前記アライメント系（ＷＡ）によるマーク検出動作が行われるように、前記干渉計システム（２６）の計測値をモニタしつつ、前記２つのステージの動作を制御した後に、前記移動手段（２０、２２）を制御して前記一方の基板ステージと他方の基板ステージの位置を入れ替える制御手段（２８）とを有する。

【００２６】これによれば、制御手段（２８）により、一方のステージに保持された感応基板が露光される間に、他方のステージ上でアライメント系（ＷＡ）によるマーク検出動作が行われるように、干渉計システム（２６）の計測値をモニタしつつ、２つのステージの動作を制御された後に、移動手段（２０、２２）が制御され、一方の基板ステージと他方の基板ステージの位置の入れ替えが行われる。このため、一方の基板ステージ側の露光動作と他方のステージ側のアライメント動作との並行処理により、スループットの向上が可能であるとともに、位置の入れ替え後に第２位置にある基板ステージ上で感応基板の交換を行なうようにすれば、両ステージの動作を入れ替えて、他方のステージに保持された感応基板が露光される間に、一方のステージ上でアライメント系（ＷＡ）によるマーク検出動作を並行して行なうことが可能になる。

【００２７】請求項３に記載の発明は、請求項２に記載の露光装置において、前記干渉計システム（２６）は、前記投影光学系（ＰＬ）の投影中心で相互に垂直に交差する第１測長軸（Ｘｅ）及び第２測長軸（Ｙｅ）と、前記アライメント系（ＷＡ）の検出中心で相互に垂直に交差する第３測長軸（Ｘａ）及び第４測長軸（Ｙａ）とを備え、前記制御手段（２８）は、前記一方と他方のステージの位置を入れ替える際に、前記干渉計システム（２６）の測長軸（Ｘｅ，Ｙｅ，Ｘａ，Ｙａ）をリセットすることを特徴とする。

【００２８】これによれば、干渉計システム（２６）が、投影光学系（ＰＬ）の投影中心で相互に垂直に交差する第１測長軸（Ｘｅ）及び第２測長軸（Ｙｅ）と、アライメント系（ＷＡ）の検出中心で相互に垂直に交差する第３測長軸（Ｘａ）及び第４測長軸（Ｙａ）とを備えていることから、投影光学系を介しての感応基板上へのパターンの露光時及びアライメント系による位置検出マークの検出時のいずれのときにおいても、アッベの誤差なく基板ステージ（ＷＳ１，ＷＳ２）の位置を正確に管理することができる。また、制御手段（２８）が、一方と他方のステージの位置を入れ替える際に、干渉計システム（２６）の測長軸（Ｘｅ，Ｙｅ，Ｘａ，Ｙａ）をリセットすることから、位置の入れ替えの際に、それまでそれぞれの基板ステージの位置を管理していた干渉計システムの測長軸が一旦切れても、干渉計システム（２６）の測長軸（Ｘｅ，Ｙｅ，Ｘａ，Ｙａ）をリセットする位置を予め所定の位置に定めておけば、リセット後は、そのリセットされた測長軸の計測値を用いて第１、第２の基板ステージの位置を管理することが可能になる。

【００２９】請求項４に記載の発明は、投影光学系（ＰＬ）を介して感応基板（Ｗ）上にパターンを露光する露光装置であって、感応基板（Ｗ）を保持して２次元平面内を移動可能な第１基板ステージ（ＷＳ１）と；感応基板（Ｗ）を保持して前記第１基板ステージ（ＷＳ１）と同一平面内を前記第１基板ステージとは独立に移動可能な第２基板ステージ（ＷＳ２）と；前記投影光学系（ＰＬ）とは別に設けられ、前記基板ステージ上又は該ステージに保持された感応基板上のマークを検出するためのアライメント系（ＷＡ）と；前記第１基板ステージ及び第２基板ステージの２次元位置をそれぞれ計測するための干渉計システム（２６）と；前記２つの基板ステージのそれぞれを、ステージ上に保持された感応基板（Ｗ）に対して前記投影光学系（ＰＬ）を介して露光が行われる露光時のステージ移動範囲内の所定の第１位置と、前記アライメント系（ＷＡ）によりステージ上又は該ステージに保持された感応基板上のマーク検出が行われるアライメント時のステージ移動範囲内の所定の第２位置と、基板ステージと外部の基板搬送機構との間で感応基板の受け渡しが行われれる第３位置の３地点間で移動させる移動手段（２０、２２）と；第１基板ステージ（ＷＳ１）及び第２基板ステージ（ＷＳ２）の内の一方のステージの位置が前記干渉計システム（２６）により管理され、該一方のステージに保持された感応基板（Ｗ）に前記投影光学系（ＰＬ）を介してパターンが露光される間に、前記第１基板ステージ及び第２基板ステージの内の他方のステージ上で感応基板（Ｗ）の交換及び前記感応基板（Ｗ）上のアライメントマークと前記他方のステージ上の基準点との位置関係を前記アライメント系（ＷＡ）の検出結果と前記干渉計システム（２６）の計測値とに基づいて計測するアライメント動作が順次行われるように前記２つの基板ステージ（ＷＳ１，ＷＳ２）及び前記移動手段（２０、２２）を制御するとともに、前記２つのステージの動作がともに終了した後に、前記２つ

のステージ上で行われる動作が入れ替わるように、前記２つのステージと前記移動手段とを制御する制御手段（２８）とを有する。

【００３０】これによれば、制御手段により、一方の基板ステージの位置が干渉計システムにより管理され、該一方の基板ステージに保持された感応基板に投影光学系を介してパターンが露光される間に、他方の基板ステージ上で感応基板（W）の交換及びその交換後の感応基板（W）上のアライメントマークと他方のステージ上の基準点との位置関係をアライメント系（WA）の検出結果と干渉計システム（２６）の計測値とに基づいて計測するアライメント動作が順次行われるように２つの基板ステージ（WS１，WS２）及び移動手段（２０、２２）が制御される。このため、一方の基板ステージ側の露光動作と他方のステージ側の感応基板の交換及びアライメント動作との並行処理により、スループットのより一層の向上が可能である。この場合、第１位置、第２位置とは異なる第３位置で感応基板の交換が行われるので、この交換をアライメント系、投影光学系とは別の位置で行なうことができ、アライメント系、投影光学系が感応基板の交換の妨げになるという不都合もない。

【００３１】また、制御手段では、２つのステージの動作がともに終了した後に、２つのステージ上で行われる動作が入れ替わるように、２つのステージと移動手段とを制御することから、上記の２つのステージの動作終了後に、これに続いて、他方のステージに保持された感応基板が露光される間に、一方のステージ上でアライメント系（WA）によるマーク検出動作を並行して行なうことが可能になる。

【００３２】この場合において、投影光学系として例えば電子鏡筒を用い、感応基板上に電子ビームによりパターンを直接描画しても良いが、請求項５に記載の発明の如く、パターンが形成されたマスク（R）を更に設け、前記マスク（R）に形成されたパターンの像が投影光学系（PL）を介して前記第１基板ステージ（WS１）及び第２基板ステージ（WS２）上の感応基板（W）に投影露光されるようにしても良い。

【００３３】請求項６に記載の発明は、請求項５に記載の露光装置において、前記干渉計システム（２６）は、前記投影光学系（PL）の投影中心で相互に垂直に交差する第１測長軸（Xｅ）及び第２測長軸（Yｅ）と、前記アライメント系（WA）の検出中心で相互に垂直に交差する第３測長軸（Xａ）及び第４測長軸（Yａ）とを備え、前記制御手段（２８）は、前記２つのステージ（WS１，WS２）のそれぞれについて、前記第１位置への移動の際に前記干渉計システム（２６）の第１及び第２測長軸（Xｅ及びYｅ）をリセットし、前記第２位置への移動の際に前記干渉計システム（２６）の第３及び第４測長軸（Xａ及びYａ）をリセットすることを特徴とする。

【００３４】これによれば、干渉計システム（２６）が、投影光学系（PL）の投影中心で相互に垂直に交差する第１測長軸（Xｅ）及び第２測長軸（Yｅ）と、アライメント系（WA）の検出中心で相互に垂直に交差する第３測長軸（Xａ）及び第４測長軸（Yａ）とを備えていることから、投影光学系を介しての感応基板上へのパターンの露光時及びアライメント系による位置検出マークの検出時のいずれのときにおいても、アッベの誤差なく基板ステージ（WS１，WS２）の位置を正確に管理することができる。また、制御手段（２８）が、２つのステージ（WS１，WS２）のそれぞれについて、第１位置への移動の際に干渉計システム（２６）の第１及び第２測長軸（Xｅ及びYｅ）をリセットし、第２位置への移動の際に干渉計システム（２６）の第３及び第４測長軸（Xａ及びYａ）をリセットすることから、いずれの基板ステージについても露光開始前、アライメント計測開始前にそれぞれの動作で必要とされる測長軸をリセットすることができ、それまでそれぞれの基板ステージの位置を管理していた干渉計システムの測長軸が一旦切れても、リセット後は、そのリセットされた測長軸の計測値を用いて露光時、アライメント時の両ステージの位置を管理することが可能になる。

【００３５】この場合において、請求項７に記載の発明の如く、前記マスク（R）のパターン像の投影中心と前記ステージ上の基準点との相対位置関係を前記マスク（R）と前記投影光学系（PL）を介して検出するマーク位置検出手段（５２A，５２B）を更に有することが望ましい。かかる場合には、投影光学系（PL）の投影領域内で基板ステージ（１８）上の所定の基準点とマスクパターン像の投影中心との位置関係が検出可能となる位置に基板ステージ（WS１、WS２）を位置決めした際に、マーク位置検出手段（５２A、５２B）によりマスク（R）のパターン像の投影中心と基板ステージ上の基準点との位置関係をマスク（R）と投影光学系（PL）とを介して検出することができる。かかる場合には、投影光学系（PL）の投影領域内で基板ステージ（１８）上の所定の基準点とマスクパターン像の投影中心との位置関係が検出可能となる位置を第１位置として定め、この位置で第１、第２測長軸のリセットをも行なうようにすることが望ましい。

【００３６】上記各発明において、請求項８に記載の発明の如く、前記各基板ステージ（WS１，WS２）が、ステージ本体（WS１ａ，WS２ａ）と、この本体（WS１ａ，WS２ａ）上に着脱自在に搭載され基板を保持する基板保持部材（WS１ｂ，WS２ｂ）とを有し、該基板保持部材（WS１ｂ，WS２ｂ）の側面には干渉計用反射面が設けられ且つ前記基板保持部材の上面には前記基準点として基準マーク（WM、RM）が形成されている場合には、前記移動手段（２０、２２）が、前記基板ステージの代わりに前記基板保持部材を前記各地点間

で移動させるようにしても良い。
【００３７】また、これらの場合において移動手段としては、第１位置、第２位置及び第３位置の３地点間（又は第１位置と第２位置との間）で、干渉計計測値をモニタ用いることなく基板ステージ又は基板保持部材を移動させるものであればどのようなものを用いても良く、例えば請求項９に記載の発明の如く、移動手段がロボットアーム（２０、２２）によって構成されていても良い。
【００３８】また、上記各発明において、干渉計システムの測長の基準となる固定鏡は、どこに配置しても良いが、請求項１０に記載の発明の如く、前記投影光学系（ＰＬ）、前記アライメント系（ＷＡ）に、それぞれ干渉計による測長の基準となる固定鏡（１４Ｘ，１４Ｙ、１８Ｘ，１８Ｙ）を取り付けても良い。この場合には、固定鏡が他の場所にある場合に比べて、経時的な固定鏡の位置変動や装置の振動に起因する固定鏡の位置変動の影響により測長結果に誤差が生じにくい。
【００３９】上記各発明では、第１基板ステージと第２基板ステージの２つのみが設けられていたが、請求項１１に記載の発明の如く、前記第１基板ステージ（ＷＳ１）及び第２基板ステージ（ＷＳ２）の他に、感応基板を保持して前記２つの基板ステージと同一平面内をこれらのステージとは独立に移動可能な少なくとも１つの別の基板ステージを更に設けても良い。
【００４０】
【発明の実施の形態】
《第１の実施形態》以下、本発明の第１の実施形態を図１ないし図４に基づいて説明する。
【００４１】図１には、第１の実施形態に係る露光装置１００の構成が示されている。この露光装置１００は、ステップ・アンド・リピート方式の縮小投影型露光装置（いわゆるステッパー）である。
【００４２】この投影露光装置１００は、照明系ＩＯＰと、マスクとしてのレチクルＲを保持するレチクルステージＲＳＴ、レチクルＲに形成されたパターンの像を感応基板としてのウエハＷ上に投影する投影光学系ＰＬ、ウエハＷを保持してベース１２上をＸＹ２次方向に移動可能な第１基板ステージとしてのウエハステージＷＳ１及びウエハＷを保持してベース１２上をウエハステージＷＳ１とは独立にＸＹ２次元方向に移動可能な第２基板ステージとしてのウエハステージＷＳ２、２つのウエハステージＷＳ１，ＷＳ２のそれぞれの位置を計測する干渉計システム２６と、ＣＰＵ，ＲＯＭ，ＲＡＭ，Ｉ／Ｏインターフェース等を含んで構成されるミニコンピュータ（又はマイクロコンピュータ）から成り装置全体を統括制御する制御手段としての主制御装置２８等を備えている。
【００４３】前記照明系ＩＯＰは、光源（水銀ランプ又はエキシマレーザ等）と、フライアイレンズ、リレーレンズ、コンデンサレンズ等から成る照明光学系とから構成されている。この照明系ＩＯＰは、光源からの露光用の照明光ＩＬによってレチクルＲの下面（パターン形成面）のパターンを均一な照度分布で照明する。ここで、露光用照明光ＩＬとしては、水銀ランプのｉ線等の輝線、又はＫｒＦ、ＡｒＦ等のエキシマレーザ光等が用いられる。
【００４４】レチクルステージＲＳＴ上には不図示の固定手段を介してレチクルＲが固定されており、このレチクルステージＲＳＴは、不図示の駆動系によってＸ軸方向（図１における紙面直交方向）、Ｙ軸方向（図１における紙面左右方向）及びθ方向（ＸＹ面内の回転方向）に微小駆動可能とされている。これにより、このレチクルステージＲＳＴは、レチクルＲのパターンの中心（レチクルセンタ）が投影光学系ＰＬの光軸Ａｅとほぼ一致する状態でレチクルＲを位置決め（レチクルアライメント）できるようになっている。図１では、このレチクルアライメントが行われた状態が示されている。
【００４５】投影光学系ＰＬは、その光軸ＡｅがレチクルステージＲＳＴの移動面に直交するＺ軸方向とされ、ここでは両側テレセントリックで、所定の縮小倍率β（βは例えば１／５）を有するものが使用されている。このため、レチクルＲのパターンとウエハＷ上のショット領域との位置合わせ（アライメント）が行われた状態で、照明光ＩＬによりレチクルＲが均一な照度で照明されると、パターン形成面のパターンが投影光学系ＰＬにより縮小倍率βで縮小されて、フォトレジストが塗布されたウエハＷ上に投影され、ウエハＷ上の各ショット領域にパターンの縮小像が形成される。
【００４６】また、本実施形態では、投影光学系ＰＬのＸ軸方向一側（図１における左側）の側面には、ウエハステージＷＳ１，ＷＳ２の露光時のＸ軸方向位置管理の基準となるＸ固定鏡１４Ｘが固定され、同様に投影光学系ＰＬのＹ軸方向一側（図１における紙面奥側）の側面には、ウエハステージＷＳ１，ＷＳ２の露光時のＹ軸方向位置管理の基準となるＹ固定鏡１４Ｙが固定されている（図３参照）。
【００４７】前記ウエハステージＷＳ１、ＷＳ２の底面には、不図示の気体静圧軸受がそれぞれ設けられており、これらの気体静圧軸受によってウエハステージＷＳ１、ＷＳ２はベース１２上面との間に数ミクロン（μｍ）程度のクリアランスを介してそれぞれベース１２上方に浮上支持されている。これらのウエハステージＷＳ１、ＷＳ２のＸ軸方向一側（図１における左側）の面及びＹ軸方向一側（図１における紙面奥側）の面には、それぞれ鏡面加工が施され、干渉計システム２６からの測長ビームを反射するための移動鏡として機能する反射面がそれぞれ形成されている。
【００４８】また、ウエハステージＷＳ１、ＷＳ２の底面には、マグネットがそれぞれ固定されており、ベース内の所定範囲（具体的には、投影光学系ＰＬ下方近傍の

所定領域及びアライメント顕微鏡ＷＡ下方近傍の所定領域）に埋め込まれた不図示の駆動コイルによって発生する電磁力によりウエハステージＷＳ１、ＷＳ２はベース１２上をＸＹ２次元方向に移動する。すなわち、ウエハステージＷＳ１、ＷＳ２底面のマグネットとベース１２内に埋め込まれた駆動コイルとによってウエハステージＷＳ１、ＷＳ２の駆動手段としてのいわゆるムービングマグネット型のリニアモータが構成されている。このリニアモータの駆動コイルの駆動電流が、主制御装置２８によって制御される。

【００４９】ウエハステージＷＳ１，ＷＳ２上には不図示のウエハホルダを介して真空吸着等によってウエハＷがそれぞれ保持されている。また、これらのウエハステージＷＳ１，ＷＳ２上には、その表面がウエハＷの表面と同じ高さになるような基準マーク板ＦＭ１、ＦＭ２がそれぞれ固定されている。一方の基準マーク板ＦＭ１の表面には、図２の平面図に示されるように、その長手方向中央部に後述するウエハアライメント顕微鏡ＷＡで計測するためのマークＷＭが形成され、このマークＷＭの長手方向両側に投影光学系ＰＬを通してレチクルＲとの相対的な位置計測に用いる一対のマークＲＭが形成されている。他方の基準マーク板ＦＭ２上にもこれとも全く同様のマークＷＭ、ＲＭが形成されている。

【００５０】更に、本実施形態では、投影光学系ＰＬからＸＹ軸に対しほぼ４５度の方向に所定距離、例えば３０００ｍｍ離れた位置にウエハＷに形成された位置検出用マーク（アライメントマーク）を検出するアライメント系としてのオフ・アクシス方式のアライメント顕微鏡ＷＡが設けられている。ウエハＷには、前層までの露光、プロセス処理により段差ができており、その中には、ウエハ上の各ショット領域の位置を測定するための位置検出用マーク（アライメントマーク）も含まれており、このアライメントマークをアライメント顕微鏡ＷＡにより計測するのである。

【００５１】アライメント顕微鏡ＷＡとしては、ここでは、画像処理方式のいわゆるＦＩＡ（field Image Alignment ）系のアライメント顕微鏡が用いられている。これによれば、ハロゲンランプ等のブロードバンドな照明光を発する不図示の光源から発せられた照明光が不図示の対物レンズを通過した後ウエハＷ（又は基準マーク板ＦＭ）上に照射され、そのウエハＷ表面の不図示のウエハマーク領域からの反射光が対物レンズ、不図示の指標板を順次透過して不図示のＣＣＤ等の撮像面上にウエハマークの像、及び指標板上の指標の像が結像される。これらの像の光電変換信号が信号処理ユニット１６内の不図示の信号処理回路により処理され、不図示の演算回路によってウエハマークと指標との相対位置が算出され、この相対位置が主制御装置２８に伝えられる。主制御装置２８では、この相対位置と干渉計システム２６の計測値とに基づいてウエハＷ上のアライメントマークの位置を算出する。

【００５２】また、アライメント顕微鏡ＷＡのＸ軸方向一側（図１における左側）の側面には、ウエハステージＷＳ１，ＷＳ２のアライメント動作時のＸ軸方向位置管理の基準となるＸ固定鏡１８Ｘが固定され、同様にアライメント顕微鏡ＷＡのＹ軸方向一側（図１における紙面奥側）の側面には、ウエハステージＷＳ１，ＷＳ２の露光動作時のＹ軸方向位置管理の基準となるＹ固定鏡１８Ｙが固定されている。

【００５３】なお、アライメント顕微鏡としてはＦＩＡ系に限らず、ＬＩＡ（Laser Interferometric Alignment）系やＬＳＡ（Laser Step Alignment）系等の他の光アライメント系は勿論、位相差顕微鏡や微分干渉顕微鏡等の他の光学装置や、トンネル効果を利用して試料表面の原子レベルの凹凸を検出するＳＴＭ（Scanning Tunnel Microscope：走査型トンネル顕微鏡）や原子間力（引力や斥力）を利用して試料表面の原子分子レベルの凹凸を検出するＡＦＭ（Atomic Force Microscope：原子間力顕微鏡）等の非光学装置等を使用することも可能である。

【００５４】更に、本実施形態の投影露光装置１００では、レチクルＲの上方に、投影光学系ＰＬを介した基準マーク板ＦＭ上の基準マークＲＭの像とレチクルＲ上のレチクルアライメントマーク（図示省略）とを同時に観察するためのマーク位置検出手段としてのレチクルアライメント顕微鏡５２Ａ、５２Ｂが設けられている。レチクルアライメント顕微鏡５２Ａ、５２Ｂの検出信号Ｓ１、Ｓ２は、主制御装置２８に供給されるようになっている。この場合、レチクルＲからの検出光をそれぞれレチクルアライメント顕微鏡５２Ａ、５２Ｂに導くための偏向ミラー５４Ａ、５４Ｂが当該各レチクルアライメント顕微鏡５２Ａ、５２Ｂと一体的にユニット化されて、一対の顕微鏡ユニット５６Ａ、５６Ｂが構成されている。これらの顕微鏡ユニット５６Ａ、５６Ｂは、露光シーケンスが開始されると、主制御装置２８からの指令により、不図示のミラー駆動装置によって、レチクルパターン面にかからない位置まで退避されるようになっている。

【００５５】次に、ウエハステージＷＳ１、ＷＳ２の位置を管理する図１の干渉計システム２６について詳述する。

【００５６】この干渉計システム２６は、実際には、図３に示されるように、Ｘ軸方向位置計測用の第１のレーザ干渉計２６Ｘｅと、Ｙ軸方向位置計測用の第２のレーザ干渉計２６Ｙｅと、Ｘ軸方向位置計測用の第３のレーザ干渉計２６Ｘａと、Ｙ軸方向位置計測用の第４のレーザ干渉計２６Ｙａとを含んで構成されているが、図１ではこれらが代表的に干渉計システム２６として図示されている。

【００５７】第１のレーザ干渉計２６Ｘｅは、Ｘ固定鏡

１４Ｘに対して投影光学系ＰＬの投影中心を通るＸ軸方向のレファレンスビームX_{e1}を投射するとともに、ウエハステージ（ＷＳ１又はＷＳ２）の反射面に対して測長ビームX_{e2}を投射し、これら２本のビームの反射光が一つに重ねられて干渉させられたその干渉状態に基づいて固定鏡１４Ｘに対するウエハステージ反射面の変位を計測する。

【００５８】また、第2のレーザ干渉計２６Ｙｅは、Ｙ固定鏡１４Ｙに対して投影光学系ＰＬの投影中心を通るＹ軸方向のレファレンスビームY_{e1}を投射するとともに、ウエハステージ（ＷＳ１又はＷＳ２）の反射面に対して測長ビームY_{e2}を投射し、これら２本のビームの反射光が一つに重ねられて干渉させられたその干渉状態に基づいて固定鏡１４Ｙに対するウエハステージ反射面の変位を計測する。

【００５９】また、第3のレーザ干渉計２６Ｘａは、Ｘ固定鏡１８Ｘに対してアライメント顕微鏡ＷＡの検出中心を通るＸ軸方向のレファレンスビームX_{a1}を投射するとともに、ウエハステージ（ＷＳ１又はＷＳ２）の反射面に対して測長ビームX_{a2}を投射し、これら２本のビームの反射光が一つに重ねられて干渉させられたその干渉状態に基づいて固定鏡１８Ｘに対するウエハステージ反射面の変位を計測する。

【００６０】また、第4のレーザ干渉計２６Ｙａは、Ｙ固定鏡１８Ｙに対してアライメント顕微鏡ＷＡの検出中心を通るＹ軸方向のレファレンスビームY_{a1}を投射するとともに、ウエハステージ（ＷＳ１又はＷＳ２）の反射面に対して測長ビームY_{a2}を投射し、これら２本のビームの反射光が一つに重ねられて干渉させられたその干渉状態に基づいて固定鏡１８Ｙに対するウエハステージ反射面の変位を計測する。

【００６１】ここで、レファレンスビームX_{e1}及び測長ビームX_{e2}から成る第１のレーザ干渉計２６Ｘｅの測長軸を第１測長軸Ｘｅ、レファレンスビームY_{e1}及び測長ビームY_{e2}から成る第２のレーザ干渉計２６Ｙｅの測長軸を第２測長軸Ｙｅ、レファレンスビームX_{a1}及び測長ビームX_{a2}から成る第３のレーザ干渉計２６Ｘａの測長軸を第３測長軸Ｘａ、レファレンスビームY_{a1}及び測長ビームY_{a2}から成る第４のレーザ干渉計２６Ｙａの測長軸を第４測長軸Ｙａと呼ぶものとすると、第１測長軸Ｘｅと第２測長軸Ｙｅとは、投影光学系ＰＬの投影中心（光軸Ａｅ中心と一致）で垂直に交差しており、第３測長軸Ｘａと第４測長軸Ｙａとは、アライメント顕微鏡ＷＡの検出中心で垂直に交差している。これにより、後述するように、ウエハW上の位置検出用マーク（アライメントマーク）の計測時にも、ウエハW上へのパターンの露光時にもウエハステージのヨーイング等によるアッベ誤差の影響を受けることなく、それぞれの計測軸方向でウエハステージの位置を正確に計測できるようになっている。なお、測定精度を向上させるべく、上記第１ないし第４のレーザ干渉計として、２周波数のヘテロダイン干渉計を用いることがより一層望ましい。

【００６２】図１に戻り、干渉計システム２６の計測値は主制御装置２８に供給され、主制御装置２８ではこの干渉計システム２６の計測値をモニタしつつ、前述したリニアモータを介してウエハステージＷＳ１，ＷＳ２を位置制御する。

【００６３】図３からも明らかなように、本第１の実施形態の場合、ウエハステージＷＳ１又はＷＳ２上のウエハWに対して投影光学系ＰＬを介したレチクルパターンの露光が行なわれる間は、第１、第２のレーザ干渉計２６Ｘｅ，２６Ｙｅによってウエハステージの位置が管理され、アライメント顕微鏡ＷＡによりウエハW上の位置検出用マーク（アライメントマーク）の計測が行なわれる間は、第３、第４のレーザ干渉計２６Ｘａ，２６Ｙａによってウエハステージの位置が管理されるようになっている。しかしながら、露光が終了した後、あるいはアライメントマークの計測が終了した後は、各測長軸がそれぞれのウエハステージの反射面に当たらなくなるので、干渉計システム２６によるウエハステージの位置管理は困難となる。

【００６４】このため、本実施形態の投影露光装置１００では、ウエハステージＷＳ１を図３中に仮想線で示される第３位置と、図３中に実線で示される第２位置と、図３中でウエハステージＷＳ２が位置する第１位置との３地点間で自在に移動させる移動手段としての第１のロボットアーム２０と、同様にウエハステージＷＳ２を上記第１位置と、第２位置と、第３位置との３地点間で自在に移動させる移動手段としての第２のロボットアーム２２とが設けられている。これら第１、第２のロボットアーム２０、２２も主制御装置２８によって制御され、これら第１、第2のロボットアーム２０、２２のウエハステージの位置制御精度は、概ね±１μm程度となっている。これらのロボットアーム２０、２２としては、公知の構成の有関節ロボットアームが用いられているので、詳細な説明は省略するが、上記の位置制御精度を確実に実現するために、図３中に符号２４Ａ、２４Ｂで示されるような上下動ピンをストッパとして併せて設けるようにしても良い。

【００６５】ここで、第３位置、第２位置及び第１位置について簡単に説明すると、第３位置とは、外部の基板搬送機構の一部を構成する搬送アーム５０とウエハステージ（ＷＳ１、ＷＳ２）との間でウエハWの受け渡しが行なわれるウエハ交換位置を意味し、第２位置とは、ウエハWのローディングが終了した後、ウエハステージ上のウエハWに対しアライメントが行なわれる位置であって第３測長軸Ｘａと第４測長軸Ｙａとが共にウエハステージの反射面に当たる任意の位置を意味し、第１位置とは、ウエハのアライメントが終了した後、ウエハステージ上のウエハWに対し露光が行なわれる位置であって第

１測長軸Ｘｅと第２測長軸Ｙｅとが共にウエハステージの反射面に当たる任意の位置を意味する。

【００６６】本実施形態では、上述したように、図３中に示される位置が、それぞれ第１位置、第２位置、第３位置として定められているものとするが、第２位置は、上記の定義を満足するのであれば、如何なる位置を定めてもよく、例えば、基準マーク板ＦＭ上のマークWMがアライメント顕微鏡ＷＡの検出領域内となる位置を第２位置としても良い。同様に、第１位置も、上記の定義を満足するのであれば、如何なる位置を定めてもよく、例えば、基準マーク板ＦＭ上のマークＲＭが投影光学系ＰＬの投影領域内となる位置を第１位置としても良い。

【００６７】次に、上述のようにして構成された本実施形態の投影露光装置１００の全体的な動作の流れを説明する。

【００６８】① 前提として、ウエハステージＷＳ１が第３位置にあり、ウエハステージＷＳ２が第１位置にあるものとする。

【００６９】まず、ウエハステージＷＳ１と搬送アーム５０との間でウエハ交換が行なわれる。このウエハ交換は、ウエハステージＷＳ１上のセンターアップ（ウエハアップ機構）と搬送アーム５０とによって従来と同様にして行なわれるので、ここでは詳細な説明するは省略するが、先に述べたようにロボットアームの位置決め精度は概ね±１ｕm以下なので、搬送アーム５０の位置決め精度もこれとほぼ同程度であるものとする。このウエハ交換に先だって、ウエハWは不図示のプリアライメント装置によりＸ，Ｙ，θ方向に概略位置決めがなされており、ウエハステージ上へのロード位置が大きくずれることはなく、例えば基準マーク板ＦＭ１に対するウエハWのロード位置も上記の±１ｕm以下の誤差範囲内となっている。

【００７０】このウエハ交換中、ウエハステージＷＳ１はレーザ干渉計で位置が管理されていないが、第１のロボットアーム２０がウエハステージＷＳ１を捉えているので、ウエハステージＷＳ１が勝手な所に行くというような不都合は生じない。なお、第１のロボットアーム２０により捉えられている間は、ウエハステージＷＳ１を駆動するリニアモータは停止しているものとする（以下において同じ）。

【００７１】ウエハ交換（ウエハステージＷＳ１上へのウエハWのロード）が終了すると、主制御装置２８では、第１のロボットアーム２０を制御してウエハステージＷＳ１を図３中に実線で示される第２位置へ移動させ、この位置で、第３、第４のレーザ干渉計２６Ｘａ，２６Ｙａを同時にリセットする。このリセットが終了すると、第１のロボットアーム２０はここでの役目を終えるので、該第１のロボットアーム２０は主制御装置２８からの指示に応じて不図示の駆動系によりウエハステージＷＳ１を離れて邪魔にならない位置に待避される。

【００７２】上記の第３、第４のレーザ干渉計２６Ｘａ，２６Ｙａのリセット終了後、主制御装置２８では干渉計２６Ｘａ，２６Ｙａの計測値をモニタしつつ、ウエハステージＷＳ１上の基準マーク板ＦＭ１上のマークＷＭがアライメント顕微鏡ＷＡの検出領域内に位置決めされるようにウエハステージＷＳ１を前述したリニアモータを介して位置制御する。ここで、第１のロボットアーム２０による第２位置への位置決め精度は、前述の如く、概ね±１ｕm以下が可能であり、この第２位置で干渉計測長軸がリセットされているので、その後は０．０１μm程度の分解能で設計値（ウエハステージＷＳ１の反射面と基準マーク板上のマークWMとの設計上の相対位置関係）に基づいて位置制御が可能であり、結果的に、アライメント顕微鏡ＷＡによるマークWM計測にとって十分な精度でウエハステージＷＳ１が位置決めされる。なお、第２位置を、ウエハステージＷＳ１上の基準マーク板ＦＭ１上のマークWMがアライメント顕微鏡ＷＡの検出領域内に位置決めされる位置に設定する場合には、上記の干渉計リセット後のウエハステージＷＳ１の移動は不要であるので、スループットの面ではより一層望ましい。

【００７３】次に、アライメント顕微鏡ＷＡによって該アライメント顕微鏡ＷＡの検出中心（指標中心）を基準とする基準マーク板ＦＭ１上のマークWMの位置（ΔW_X，ΔW_Y）が計測され、主制御装置２８ではこの計測中の第３、第４のレーザ干渉計２６Ｘａ，２６Ｙａの計測値の平均値（X_0，Y_0）を求める。これによりレーザ干渉計２６Ｘａ，２６Ｙａの計測値が（$X_0 - \Delta W_X$，$Y_0 - \Delta W_Y$）を示すとき基準マーク板ＦＭ１上のマークWMがアライメント顕微鏡ＷＡの検出中心（指標中心）の真下にいることが分かる。上記の第３、第４のレーザ干渉計２６Ｘａ，２６Ｙａのリセット後の一連の動作を以下においてはＷ－ＳＥＴと呼ぶものとする。

【００７４】このようにして、一方のウエハステージＷＳ１上でウエハ交換、干渉計リセット及びＷ－ＳＥＴの一連の動作が行なわれる間に、他方のウエハステージＷＳ２上では、次のような動作が行なわれる。

【００７５】すなわち、ウエハステージＷＳ２は、前述の如く、第２のロボットアーム２２により第１位置へ移動されており、この第１位置への位置決め制御も±１ｕm以下の精度で行なわれている。この第１位置へのウエハステージＷＳ２の移動が完了すると同時に、主制御装置２８では第１、第２のレーザ干渉計２６Ｘｅ，２６Ｙｅをリセットする。

【００７６】この第１、第２のレーザ干渉計２６Ｘｅ，２６Ｙｅのリセットが終了すると、第２のロボットアーム２２はここでの役目を終えるので、該第２のロボットアームは主制御装置２８からの指示に応じて不図示の駆動系によりウエハステージＷＳ２を離れて邪魔にならない位置に待避される。

【００７７】次に、主制御装置２８ではレーザ干渉計２６Ｘｅ，２６Ｙｅの計測値をモニタしつつ、基準マーク板ＦＭ２上のマークＲＭが、投影光学系ＰＬの投影領域内でレチクルＲに形成されているレチクルアライメントマーク（図示省略）に投影光学系を介して重なる位置に、位置決めされるように、リニアモータを介してウエハステージＷＳ２の位置を制御する。この場合、第２のロボットアーム２２による第１位置への位置決め精度は、前述の如く、概ね±１ｕｍ以下が可能であり、この第１位置で干渉計測長軸がリセットされているので、その後は０．０１μｍ程度の分解能で設計値（ウエハステージＷＳ２の反射面と基準マーク板ＦＭ２上のマークＲＭとの設計上の相対位置関係）に基づいて位置制御が可能であり、結果的に、レチクルアライメント顕微鏡５２Ａ、５２Ｂでレチクルアライメントマークと基準マーク板ＦＭ上のマークＲＭを同時に観測するには必要十分な精度でウエハステージＷＳ２は位置決めされる。

【００７８】次に、レチクルアライメント顕微鏡５２Ａ、５２ＢによってレチクルＲ上のレチクルアライメントマークと基準マーク板ＦＭ２上のマークＲＭの相対間隔（ΔＲＸ，ΔＲＹ）、すなわち投影光学系ＰＬの投影領域内の所定の基準点としてのレチクルＲのパターン像の投影中心に対するウエハステージＷＳ２上の基準点である基準マークＲＭ中心との位置ずれ（ΔR_X，ΔR_Y）が計測され、主制御装置２８では、このレチクルアライメント顕微鏡５２Ａ、５２Ｂの計測値を取り込むと同時に、その時のレーザ干渉計２６Ｘｅ，２６Ｙｅの計測値（X_1，Y_1）を読み取る。これにより、レーザ干渉計２６Ｘｅ，２６Ｙｅの計測値が（$X_1 - \Delta R_X$，$Y_1 - \Delta R_Y$）となる位置が、レチクルアライメントマークと基準マーク板ＦＭ２上のマークＲＭがちょうど投影光学系ＰＬを介して重なる位置であることが分かる。上記の第１、第２のレーザ干渉計２６Ｘｅ，２６Ｙｅのリセット後の一連の動作を以下においてはＲ－ＳＥＴと呼ぶものとする。

【００７９】②次に、ウエハステージＷＳ１側のウエハアライメントとウエハステージＷＳ２側の露光とが並行して行なわれる。

【００８０】すなわち、前述した第３、第４のレーザ干渉計２６Ｘａ、２６Ｙａのリセット後は、ウエハステージＷＳ１の位置は、レーザ干渉計２６Ｘａ、２６Ｙａの計測値に基づいて管理されており、主制御装置２８ではウエハＷ上の複数のショット領域の内、予め定められた特定のサンプルショットの位置検出用マーク（アライメントマーク）位置の計測を、干渉計２６Ｙａ、２６Ｘａの計測値をモニタしつつリニアモータを介してウエハステージＷＳ１を順次移動して、アライメント顕微鏡ＷＡの出力に基づいて（Ｘａ，Ｙａ）座標系上で行なう。この場合、基準マーク板ＦＭ１上のマークＷＭがアライメント顕微鏡ＷＡの検出中心の真下に来るときの干渉計の計測値（$X_0 - \Delta_X$，$Y_0 - \Delta_Y$）が求まっているため、この値と、基準マークＷＡと各アライメントマークの相対位置の設計値とに基づいてウエハＷ上の各アライメントマークをウエハアライメント顕微鏡ＷＡの検出領域内に位置決めするためにはレーザ干渉計２６Ｙａ、２６Ｘａの計測値がどの値を示す位置にウエハステージＷＳ１を移動させれば良いかが演算で求められ、この演算結果に基づいてウエハステージＷＳ１が順次移動される。

【００８１】ウエハＷのＸ、Ｙ、θの位置合わせのためには、最低でもＸ計測マーク２個とＹ計測マーク１個（またはＸ計測マーク１個とＹ計測マーク２個）を計測を行なえば足りるが、ここでは、ＥＧＡサンプルショットとして、一直線上に無いＸ計測マーク３個以上、一直線上に無いＹ計測マーク３個以上の計測が行なわれるものとする。

【００８２】そして、この計測した各サンプルショットのアライメントマーク（ウエハマーク）位置と設計上のショット領域の配列データとを用いて、例えば特開昭６１－４４４２９号公報等に開示されるような最小自乗法による統計演算を行なって、ウエハＷ上の上記複数ショット領域の全配列データを求める。但し、計算結果は、先に求めた基準マーク板ＦＭ１上のマークＷＭがアライメント顕微鏡ＷＡの検出中心の直下に来たときの干渉計の値（$X_0 - \Delta_X$，$Y_0 - \Delta_Y$）と差をとって、基準マーク板ＦＭ１上の基準マークＷＡを基準とするデータに変換しておくことが望ましい。これにより、基準マーク板ＦＭ１上のマークＷＭとウエハＷ上の各ショット領域の基準点との相対的な位置関係が必要にして十分に分かる。

【００８３】このようにして、ウエハステージＷＳ１側でファインアライメント（ＥＧＡ）が行なわれるのと並行して、ウエハステージＷＳ２側では、次のようにしてレチクルＲのパターン像とウエハＷ上のショット領域の既成のパターンとの重ね合わせ露光が行なわれる。

【００８４】すなわち、主制御装置２８では上記の位置ずれ誤差の計測結果と、そのときのウエハステージＷＳ２の座標位置（Ｘｅ，Ｙｅ）と、予めアライメント動作により上記と同様にして算出している基準マーク板ＦＭ２上の基準マークＷＡを基準とする各ショットの配列座標データとに基づいて、干渉計２６Ｙｅ、２６Ｘｅの計測値をモニタしつつウエハＷ上の各ショット領域を露光位置に位置決めしつつ、照明光学系内のシャッタを開閉制御しながら、ステップ・アンド・リピート方式でレチクルパターンをウエハＷ上に順次露光する。ここで、ウエハステージＷＳ２上のウエハＷに対する露光に先立って、干渉計２６Ｘｅ、２６Ｙｅをリセットしている（干渉計の測長軸が一旦切れている）にもかかわらず、高精度な重ね合わせが可能な理由について、詳述すると、基準マーク板ＦＭ２上のマークＷＭとマークＲＭとの間隔

は既知であり、これに先立って行われたファインアライメント（ＥＧＡ）により前述と同様にして基準マーク板ＦＭ２上のマークWMとウエハW上の各ショット領域の基準点との相対的な位置関係が算出されており、レチクルR上のレチクルアライメントマークがレチクルR上のどこに存在するか（即ち、投影光学系ＰＬの投影領域内の所定の基準点であるレチクルのパターン像の投影中心（投影光学系ＰＬの投影中心とほぼ一致）とウエハステージＷＳ２上の基準点であるマークＲＭとの相対位置関係）も計測されているので、これらの計測結果に基づき、第１、第２のレーザ干渉計２６Ｘｅ、２６Ｙｅの計測値がどの値になればレチクルＲのパターン像とウエハW上各ショット領域がぴったり重なるかは明白だからである。

【００８５】③　上述のようにして、ウエハステージＷＳ１側でファインアライメント（ＥＧＡ）が終了し、ウエハステージＷＳ２側でウエハW上の全てのショット領域に対するレチクルパターンの露光が終了すると、ウエハステージＷＳ１を投影光学系ＰＬの下方の第１位置へ移動し、ウエハステージＷＳ２をウエハ交換位置である第３位置に移動する。

【００８６】すなわち、ウエハステージＷＳ１は主制御装置２８からの指示に応じて第１のロボットアーム２０によって捕捉され、第１位置へ移動される。この第１位置への位置決め制御も±１ｕｍ以下の精度で行なわれる。この第１位置へのウエハステージＷＳ１の移動が完了すると同時に、主制御装置２８では第１、第２のレーザ干渉計２６Ｘｅ，２６Ｙｅをリセットする。

【００８７】このリセットが終了すると、第１のロボットアーム２０はここでの役目を終えるので、該第１のロボットアーム２０は主制御装置２８からの指示に応じて不図示の駆動系によりウエハステージＷＳ１を離れて邪魔にならない位置に待避される。

【００８８】次に、主制御装置２８では先に述べたウエハステージＷＳ２側と同様にして、Ｒ－ＳＥＴを行なう。これにより、レチクルアライメントマークと基準マーク板ＦＭ１上のマークＲＭの相対間隔（ΔR_X，ΔR_Y）、すなわち投影光学系ＰＬの投影領域内の所定の基準点としてのレチクルＲのパターン像の投影中心に対するウエハステージＷＳ２上の基準点である基準マークＲＭ中心との位置ずれ（ΔR_X，ΔR_Y）及びこの位置ずれ計測時のステージ座標位置（X_1，Y_1）が計測される。

【００８９】ウエハステージＷＳ１側で上述のようにして、干渉計リセット及びＲ－ＳＥＴが行われる間に、主制御装置２８からの指示に応じて第２のロボットアーム２２が露光動作が終了したウエハステージＷＳ２を捕捉し、ウエハ交換のためウエハ受け渡し位置（第３位置）にウエハステージＷＳ２を移動させ、以後前述したウエハステージＷＳ１側と同様にしてウエハ交換、干渉計リセット及びＷ－ＳＥＴが行われる。

【００９０】④　次いで、主制御装置２８では、前述と同様に、ウエハステージＷＳ１側でステップ・アンド・リピート方式でレチクルパターンがウエハW上に順次露光されるのと並行して、ウエハステージＷＳ２側でファインアライメント（ＥＧＡ）が行なわれるように両ステージの動作を制御する。

【００９１】⑤その後は、これまでに説明した①～④の動作が順次繰り返されるように、主制御装置２８によって、両ステージＷＳ１、ＷＳ２の動作、第１、第２のロボットアームの動作が制御される。

【００９２】以上説明した、両ステージＷＳ１、ＷＳ２上で行われるの並行動作の流れが、図４に示されている。

【００９３】以上説明したように、本第１の実施形態に係る投影露光装置１００によると、ウエハステージＷＳ１及びウエハステージＷＳ２の内の一方のステージ側の露光動作と他方のステージ側のファインアライメント動作を並行して行なうことができるので、ウエハ交換（サーチアライメントを含む）、ファインアライメント、露光をシーケンシャルに行なっていた従来技術に比べて、スループットの大幅な向上が期待できる。通常、露光処理シーケンスの中では、ファインアライメント動作と露光動作に要する時間の割合が大きいからである。

【００９４】また、上記実施形態によると、干渉計システム２６の測長軸が切れることを前提としているので、各ウエハステージの反射面（移動鏡を用いる場合は該移動鏡）の長さは、ウエハ直径より僅かに長い程度で十分であることから、測長軸が切れてはいけないことを前提としていた従来技術に比べて、ウエハステージの小型・軽量化が可能であり、これによりステージ制御性能の向上が期待される。

【００９５】さらに、上記実施形態では、干渉計システムの測長軸が切れることを前提とし、アライメント前、露光前それぞれにおいてステージ上の基準マーク板ＦＭ上のマーク位置を測定するので、投影光学系ＰＬの投影中心とアライメント顕微鏡ＷＡの検出中心との中心間距離（ベースライン量）はいくら長くなっても特に不都合はなく、投影光学系ＰＬとアライメント顕微鏡ＷＡの間隔をある程度十分に離して、ウエハステージＷＳ１とウエハステージＷＳ２とが干渉等を生じることなく、ウエハアライメントと露光とを時間的に並行して行なうことができる。

【００９６】また、上記実施形態では、投影光学系ＰＬの投影中心で垂直に交差する第１測長軸Ｘｅと第２測長軸Ｙｅ、及びアライメント顕微鏡ＷＡの検出中心で垂直に交差する第３測長軸Ｘａと第４測長軸Ｙａを干渉計システム２６が備えていることから、アライメント動作時及び露光時のいずれの時においてもウエハステージの２次元位置を正確に管理することができる。

【００９７】これに加え、投影光学系ＰＬの側面、アライメント顕微鏡ＷＡの側面に干渉計用固定鏡１４Ｘ、１４Ｙ、１８Ｘ、１８Ｙを固定したことから、アライメント計測中、露光中に固定鏡位置の変動がない限り、仮に経時的変化や装置の振動等によって固定鏡位置が変動しても、この変動によりウエハステージの位置制御精度が低下する等の不都合が生じることがない。従って、例えば、アライメント顕微鏡ＷＡを上下動可能な構成にしても何らの不都合をも生じない。

【００９８】なお、上記第１の実施形態では、第１、第２のロボットアーム２０、２２により、ウエハステージＷＳ１、ウエハステージＷＳ２を第１位置、第２位置及び第３位置の３地点間で移動させる場合について説明したが、本発明がこれに限定させるものではなく、例えば第２位置でウエハ交換を行なうようにする場合には、第１、第２のロボットアーム２０、２２により、ウエハステージＷＳ１、ウエハステージＷＳ２を第１位置と第２位置間で移動させるようにしても良い。この場合には、主制御装置２８では、ウエハステージＷＳ１及びウエハステージＷＳ２の内の一方のステージ上のウエハＷの露光動作と、他方のステージ上のウエハＷのアライメント動作とが並行して行われるように両ステージの動作を制御した後に、第１、第２のロボットアーム２０、２２により両ステージの位置を入れ替えることとなる。

【００９９】また、上記第１の実施形態では、ＥＧＡ計測に基づいてステップ・アンド・リピート方式の露光がステージ上のウエハＷに対して行われる場合について説明したが、これに限らず、ダイ・バイ・ダイによってアライメント、露光を繰り返しながらウエハＷ上の各ショット領域に順次レチクルのパターン像を投影露光しても良い。この場合であっても、アライメント時にステージ上の基準マーク板ＦＭに形成されたマークＷＭに対する各アライメントマークの相対位置が計測されるので、この相対位置に基づいて上記と同様にして、各ショット領域にレチクルパターン像を重ね合わせることができる。かかるダイ・バイ・ダイ方式は、ウエハＷ上のショット領域の数が少ない場合に採用することが望ましい。ショット領域の数が多い場合は、スループットの低下を防止する観点から考えて前述したＥＧＡによる方が望ましい。

【０１００】また、上記第１の実施形態では、第１のロボットアーム２０が一方のステージＷＳ１を第１位置、第２位置及び第３位置の３地点間で移動させ、第２のロボットアーム２２が他方のステージＷＳ２を第１位置、第２位置及び第３位置の３地点間で移動させる場合について説明したが、本発明がこれに限定されることはなく、例えば一方のロボットアーム２０がステージＷＳ１（又はＷＳ２）を第１位置から第３位置まで運ぶ途中で第１位置、第２位置及び第３位置以外のある位置まで運んで放し、他方のロボットアーム２２が該ステージＷＳ１（又はＷＳ２）をこの位置から第３位置まで移動させる等の方式を採用することにより、一方のロボットアーム２０を両ステージの第２位置と第１位置との搬送専用とし、他方のロボットアーム２を両ステージの第３位置と第２位置との搬送専用とすることも可能である。

【０１０１】また、干渉計システム２６を構成する各レーザ干渉計として、多軸の干渉計を用い、ウエハステージのＸ、Ｙの並進位置のみでなく、ヨーイングや、ピッチングをも計測するようにしても良い。

【０１０２】《第２の実施形態》次に、本発明の第２の実施形態を図５に基づいて説明する。ここで、前述した第１の実施形態と同一若しくは同等の構成部分については、同一の符号を用いるとともにその説明を省略するものとする。

【０１０３】この第２の実施形態は、ウエハステージＷＳ１が、ステージ本体ＷＳ１ａと、このステージ本体ＷＳ１ａ上に着脱可能な同一形状の基板保持部材ＷＳ１ｂとの２部分に分離可能に構成され、同様にウエハステージＷＳ２が、ステージ本体ＷＳ２ａと、このステージ本体ＷＳ２ａ上に着脱可能な同一形状の基板保持部材ＷＳ２ｂとの２部分に分離可能に構成されている点に特徴を有する。

【０１０４】基板保持部材ＷＳ１ｂ、ＷＳ２ｂには、ウエハＷが不図示のウエハホルダを介して吸着保持されているとともに、干渉計用移動鏡として機能する反射面がその側面にそれぞれ形成されている。また、これらの基板保持部材ＷＳ１ｂ、ＷＳ２ｂには、その上面に基準マーク板ＦＭ１、ＦＭ２がそれぞれ設けられている。

【０１０５】本第２の実施形態では、前述した第１の形態とほぼ同様にして、ウエハステージＷＳ１、ＷＳ２上で並行処理が行われるが、一方のステージ側でアライメント動作が終了し、他方のステージ側で露光動作が終了した時点で、主制御装置２８により第１、第２のロボットアーム２０、２２が制御され、アライメント動作が終了したステージ側の基板保持部材ＷＳ１ｂ（又はＷＳ２ｂ）が第１位置で停止しているステージ本体ＷＳ２ａ上に搬送（移動）されるのと並行して、露光が終了したステージ側の基板保持部材ＷＳ２ｂ（又はＷＳ１ｂ）が第２位置で停止しているステージ本体ＷＳ１ａ上に搬送され、このようにして基板保持部材ＷＳ１ｂ、ＷＳ２ｂの交換が行われる。基板保持部材ＷＳ１ｂ、ＷＳ２ｂが交換される際、干渉計システム２６の測長軸は切れるためウエハステージＷＳ１、ＷＳ２の位置管理が不能となるので、その間はステージストッパ３０ａ、３０ｂが出てきて両ステージ本体ＷＳ１ａ、ＷＳ２ａをその位置に保持するようになっている。この場合、ウエハ交換は、不図示の搬送アームにより第２位置で行われる。

【０１０６】ここで、本第２の実施形態では、図５から容易に想像されるように、第２位置として、例えば基準マーク板ＦＭ上のマークＷＭがアライメント顕微鏡ＷＡ

の検出領域内となる位置が、第１位置として、基準マーク板ＦＭ上のマークＲＭが投影光学系ＰＬの投影領域内となる位置がそれぞれ定められており、従って、主制御装置２８により基板保持部材ＷＳ１ｂ、ＷＳ２ｂのステージ本体上への移動とともに干渉計システム２６の測長軸のリセット及びＲ－ＳＥＴ又はＷ－ＳＥＴが行なわれることとなる。

【０１０７】この第２の実施形態によっても、前述した第１の実施形態と同等の効果を得ることができる。

【０１０８】なお、上記第２の実施形態では、第１、第２のロボットアーム２０、２２が基板保持部材を第１位置と第２位置間で移動させる場合について説明したが、第１、第２のロボットアーム２０、２２が、前述した第１の実施形態と同様に、基板保持部材を第１位置、第２位置及び第３位置の３地点間で移動させるようにしても良い。この場合には、ウエハ交換を投影光学系ＰＬ、アライメント顕微鏡ＷＡと無関係な所で行なうことができるので、例えばアライメント顕微鏡ＷＡ下方のワーキングディスタンスが狭い場合であっても、アライメント顕微鏡ＷＡがウエハ交換の障害になる等の不都合がない。

【０１０９】なお、上記第１、第２の実施形態では、干渉計システム２６の測長軸が一旦切れる際の対策として、ロボットアームや、ステージストッパなるものを使用する場合について説明したが、これに限らず、例えばウエハステージ下面に二次元グレーティングを刻んでおき、ステージ走り面の下から光学式のエンコーダにより位置を読み取っても良く、干渉計測長軸が一旦切れた状態でステージを次の位置へ正確に移動させることができる手段、又はステージ本体を所定の位置で停止させたまま保持できるものであれば、如何なる手段を用いても良い。

【０１１０】また、上記第１、第２の実施形態では、独立に移動するウエハステージが２つ設けられた場合について説明したが、独立に移動するウエハステージを３つ以上設けても良い。ウエハステージを３つ設けた場合には、例えば露光動作、アライメント動作、ウエハ平坦度測定動作を並行して行なうことができる。また、投影光学系ＰＬやアライメント顕微鏡ＷＡを複数設けて良い。投影光学系が複数ある場合には、アライメント動作と異なる二種類のパターンの露光動作とを同時並行的に行なうことができ、いわゆる二重露光等に適する。

【０１１１】更に、上記実施形態では、本発明がステップ・アンド・リピート方式の投影露光装置に適用された場合を例示したが、本発明の適用範囲がこれに限定されるものではなく、本発明はいわゆるステップ・アンド・スキャン方式の投影露光装置は勿論、この他、例えば電子ビーム直接描画装置等の他の露光装置にも適用できるものである。

【０１１２】

【発明の効果】以上説明したように、請求項１に記載の発明によれば、スループットを向上させることができるとともに、ベースライン量に無関係に基板ステージの大きさを定めることができるという従来にない優れた露光方法が提供される。

【０１１３】また、請求項２ないし１１に記載の発明によれば、一方の基板ステージ上の露光動作と他方のステージ上のアライメント動作とを並行処理することにより、スループットを向上させることができるという効果がある。

【図面の簡単な説明】

【図１】第１の実施形態に係る露光装置の全体構成を概略的に示す図である。

【図２】図１の一方のウエハステージの概略平面図である。

【図３】図１の装置の概略平面図である。

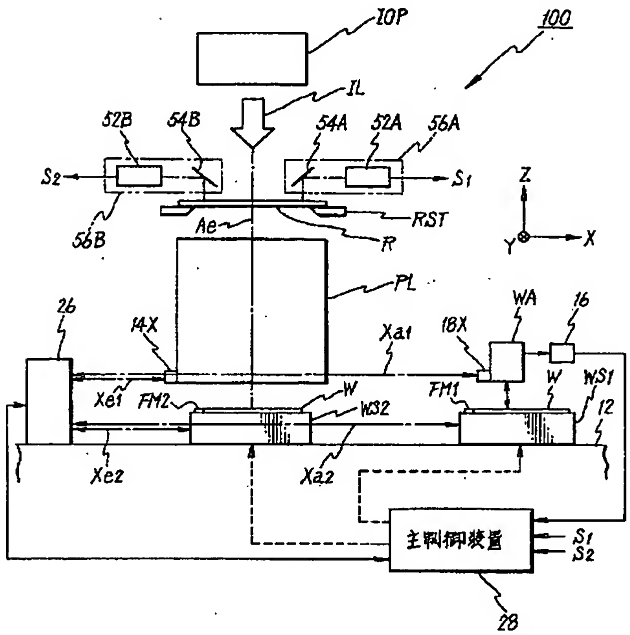
【図４】図１の装置における動作の流れを示す図である。

【図５】第２の実施形態に露光装置の主要部の構成を示す概略平面図である。

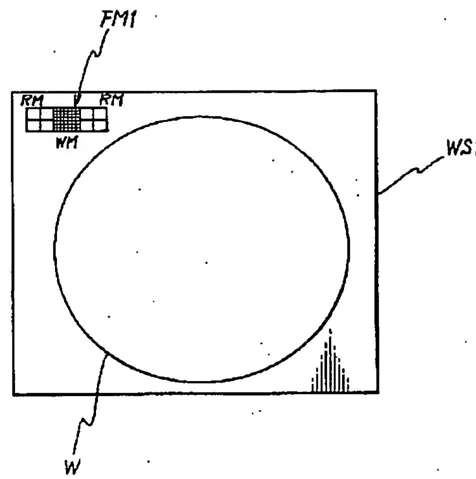
【符号の説明】

１４Ｘ、１８Ｘ　Ｘ固定鏡（固定鏡）
１４Ｙ、１８Ｙ　Ｙ固定鏡（固定鏡）
２０　第１のロボットアーム（移動手段）
２２　第２のロボットアーム（移動手段）
２６　干渉計システム
２８　主制御装置（制御手段）
５０　搬送アーム（基板搬送機構の一部）
５２Ａ、５２Ｂ　レチクルアライメント顕微鏡（マーク位置検出手段）
１００　露光装置
ＷＳ１ａ、ＷＳ２ａ　ステージ本体
ＷＳ１ｂ、ＷＳ２ｂ　基板保持部材
ＦＭ１、ＦＭ２　基準マーク板
ＷＭ、ＲＭ　基準マーク
Ｒ　レチクル（マスク）
Ｗ　ウエハ（感応基板）
ＰＬ　投影光学系
ＷＳ１　ウエハステージ（第１基板ステージ）
ＷＳ２　ウエハステージ（第２基板ステージ）
ＷＡ　アライメント顕微鏡（アライメント系）
Ｘｅ　第１測長軸
Ｙｅ　第２測長軸
Ｘａ　第３測長軸
Ｙａ　第４測長軸

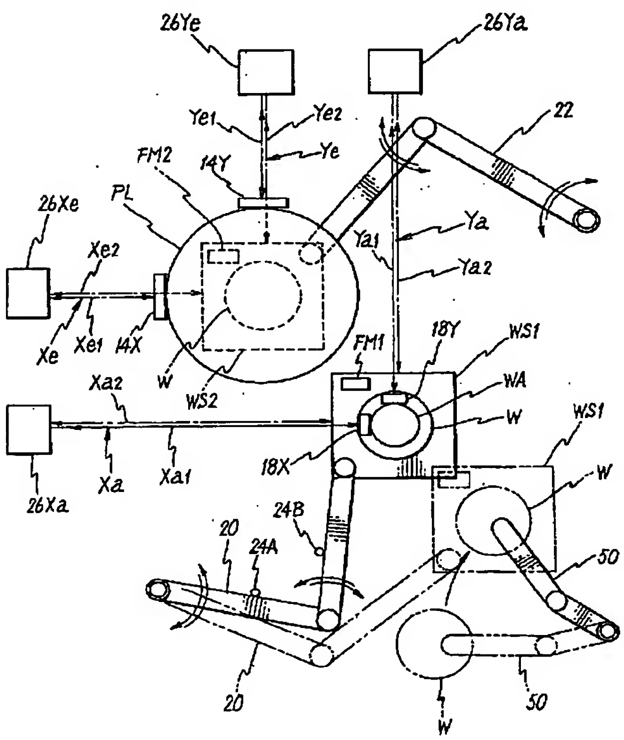
【図１】


10P
100
IL
52B
54B
54A
52A
56A
S2
S1
56B
RST
Ae
R
Z
Y
X
PL
26
14X
Xa1
18X
WA
16
Xe1
FM2
W
WS2
FM1
W
WS1
12
Xe2
Xa2
主制御装置
S1
S2
28

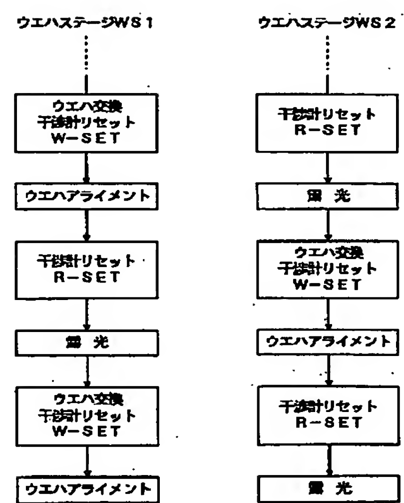
【図２】


FM1
RM
RM
WM
WS1
W

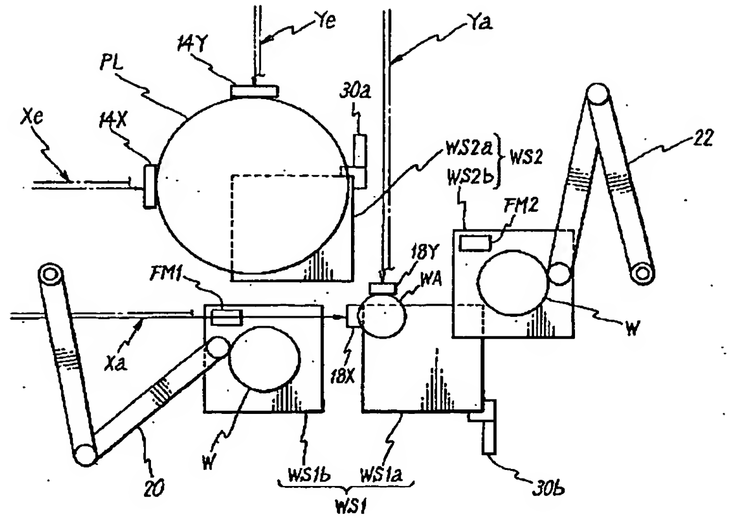
【図３】


26Ye
26Ya
Ye1
Ye2
Ye
22
FM2
14Y
PL
26Xe
Ya
Xe2
Ya1
Ya2
Xe
Xe1
14X
W
FM1
18Y
WS1
Xa2
WS2
WA
W
18X
WS1
26Xa
Xa
Xa1
24B
W
20
24A
50
20
50
W

【図４】


ウエハステージWS１
ウエハ交換
干渉計リセット
W－SET
ウエハアライメント
干渉計リセット
R－SET
露　光
ウエハ交換
干渉計リセット
W－SET
ウエハアライメント
ウエハステージWS２
干渉計リセット
R－SET
露　光
ウエハ交換
干渉計リセット
W－SET
ウエハアライメント
干渉計リセット
R－SET
露　光

【図５】


Ye
Ya
14Y
PL
30a
Xe
14X
WS2a
WS2b
WS2
22
FM2
18Y
WA
FM1
Xa
18X
W
W
20
WS1b
WS1a
WS1
30b

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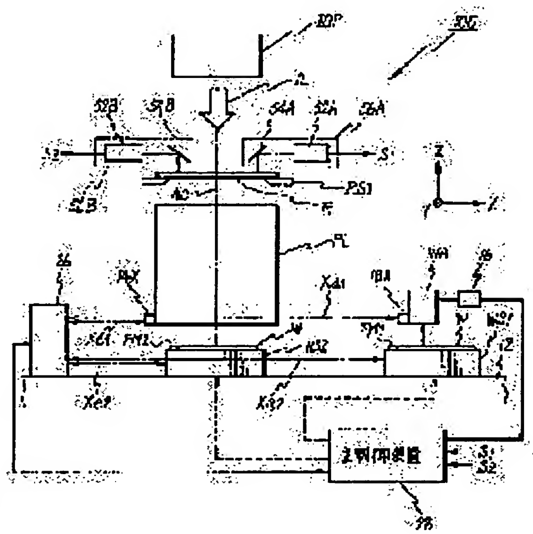
(54) LIGHT-EXPOSURE DEVICE AND LIGHT-EXPOSURE METHOD

(57)Abstract:
PROBLEM TO BE SOLVED: To provide a light-exposure method capable of enhancing the throughput and deciding the size of a substrate stage irrespective of a base line amount.
SOLUTION: For example, while a pattern image of a mask R is exposed to lights via a projection optical system PL on a substrate W held by a stage WS2, a location relations between a positioning mark on the substrate W held by a stage WS1 and a reference point on the stage WS1 is measured. After the substrate W held by the stage WS2 is completed being exposed to lights, under a state that a reference point on the stage WS1 is positioned in a projection region of the projection optical system PL, location deviations of the reference point on the stage WS1 with respect to a specific reference point in the projection region and a coordinate location of the stage WS1 at the time of detecting the location deviations are detected. Thereafter, movements of the stage WS1 are controlled based on the detection results, and the substrate W held by the stage WS1 is positioned to the pattern image of the mask R.



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